Choosing The Best Educational Software

COMPUTE!

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September
1984
Issue 52
Vol. 6, No. 9
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The Leading Magazine Of Home, Educational, And Recreational Computing

Two Exciting Games:
Missile Math For Apple, IBM PC And PCjr, Atari, Commodore 64, TI-99/4A, And VIC-20
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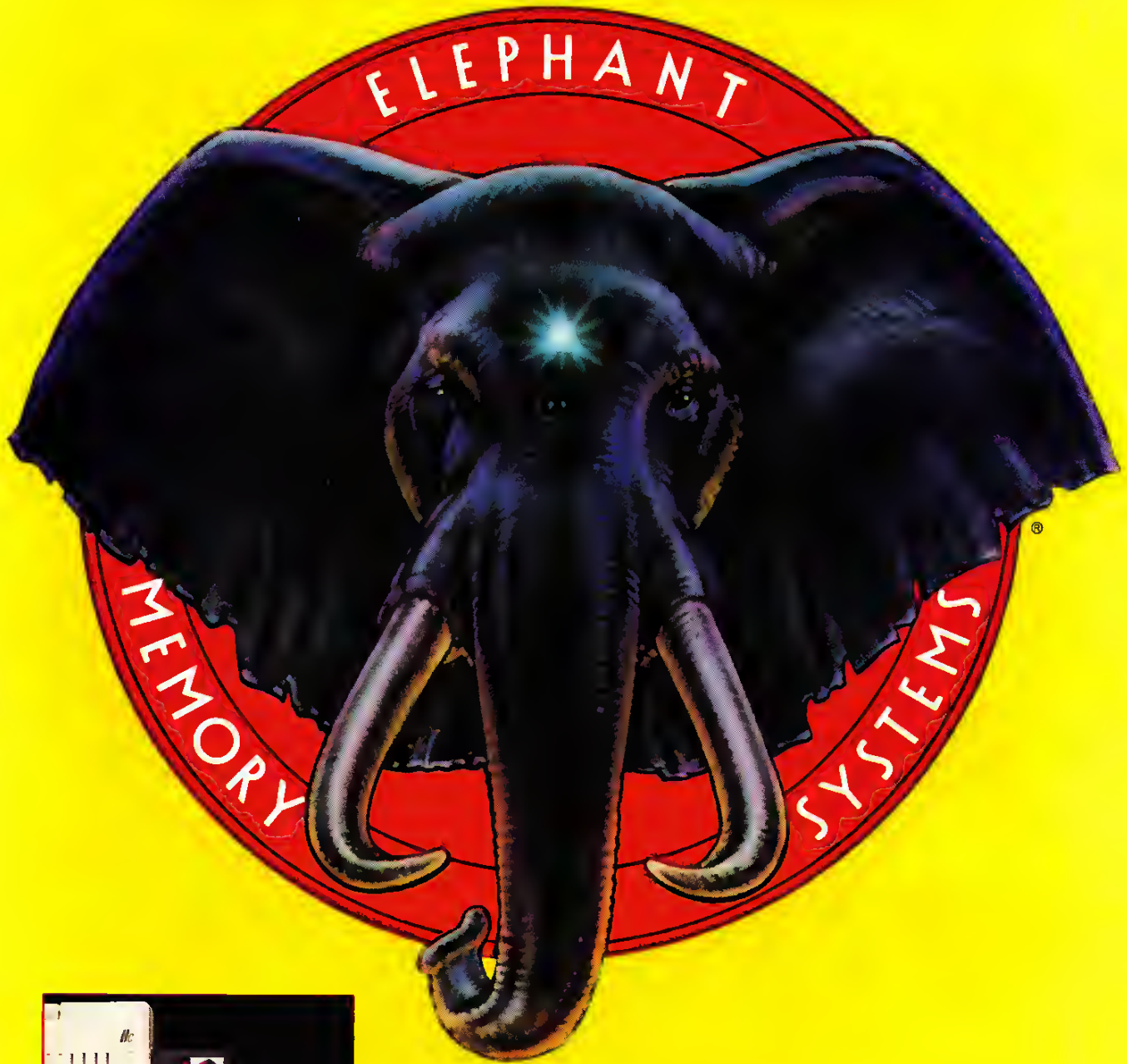

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That is, until Spinnaker created the Learning Adventure Series. A unique collection of games that reward curiosity with hours of adventure and learning. So the time kids spend with our games will help them develop valuable skills. Instead of just tired thumbs.

But what really makes our Learning Adventure games unique—educational value aside—is how much fun they are. Which isn't too surprising when you consider you can do things like bargain with aliens, search a haunted house, or build your own railroad empire.

In fact, our games are so much fun, kids will really enjoy developing some very important skills. Deductive reasoning, note taking, and problem solving, for instance.

So, if you're in the market for software that will truly cultivate young minds, pick the Spinnaker Learning Adventure Series.

It's the best way to be sure your search will be fruitful.

Spinnaker Learning Adventure games are available for Apple,® Atari,® IBM® and Commodore 64™ home computers.

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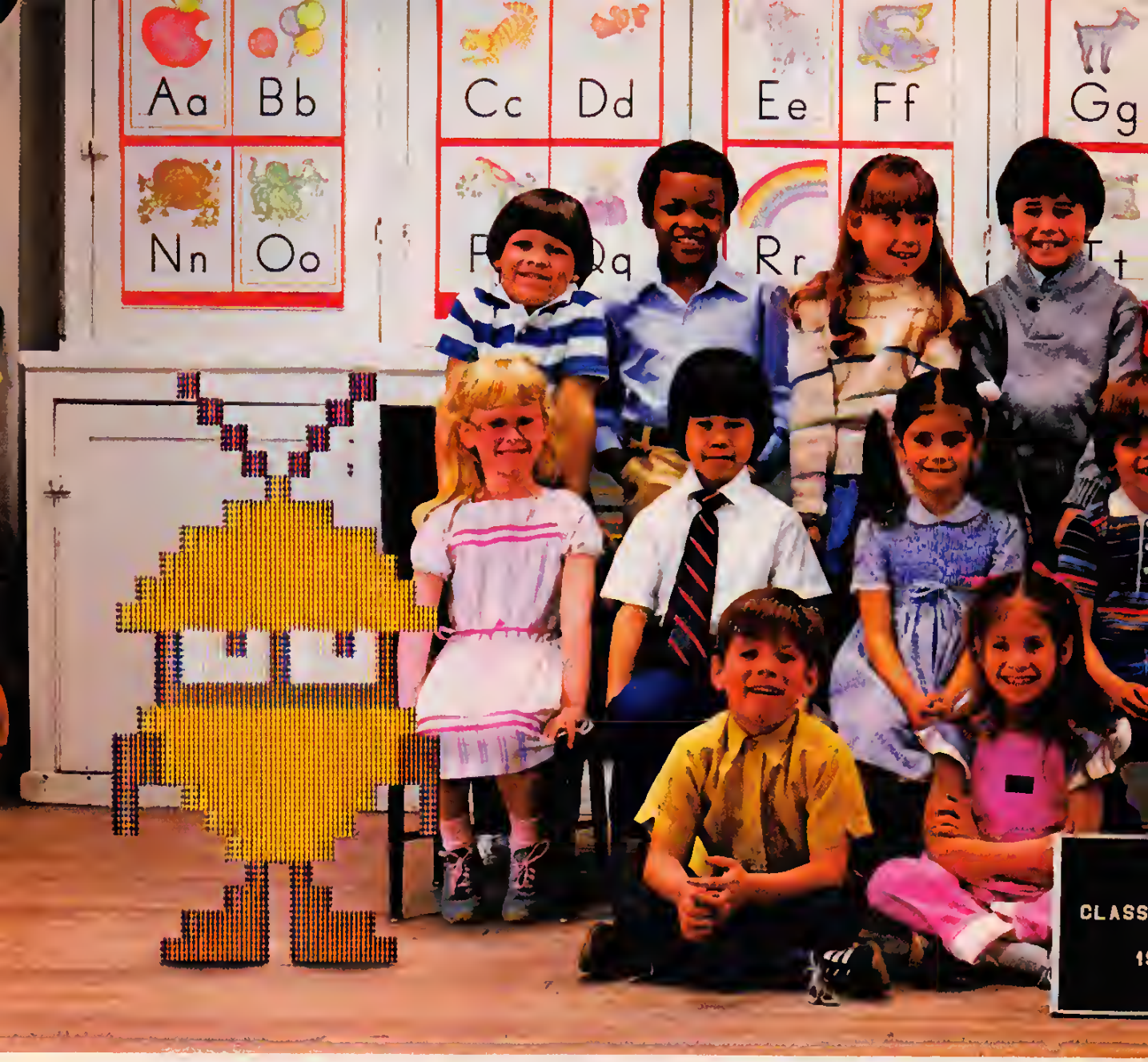

Modern times have create

We've cleverly disguised them as funny creatures from a computer game. But underneath the funny exterior is one of the most serious approaches to home education you've ever heard of.

INTRODUCING SPROUT™ SOFTWARE. GAMES THAT TEACH.

Your kid's new teachers are called Tink and Tonk. They come from Sprout. Software for kids 4 to 8.

The beauty of Sprout software is how entertainment is balanced with a healthy dose of education.

While kids are having fun at home, they're actually reinforcing what they've learned at school. Things like the alphabet, spelling, vocabulary, counting, adding, and pattern recognition.

You'll also like how Sprout prevents boredom. Our games grow up, instead of wear out. As kids get older, the game adjusts and gets harder. Because there are many

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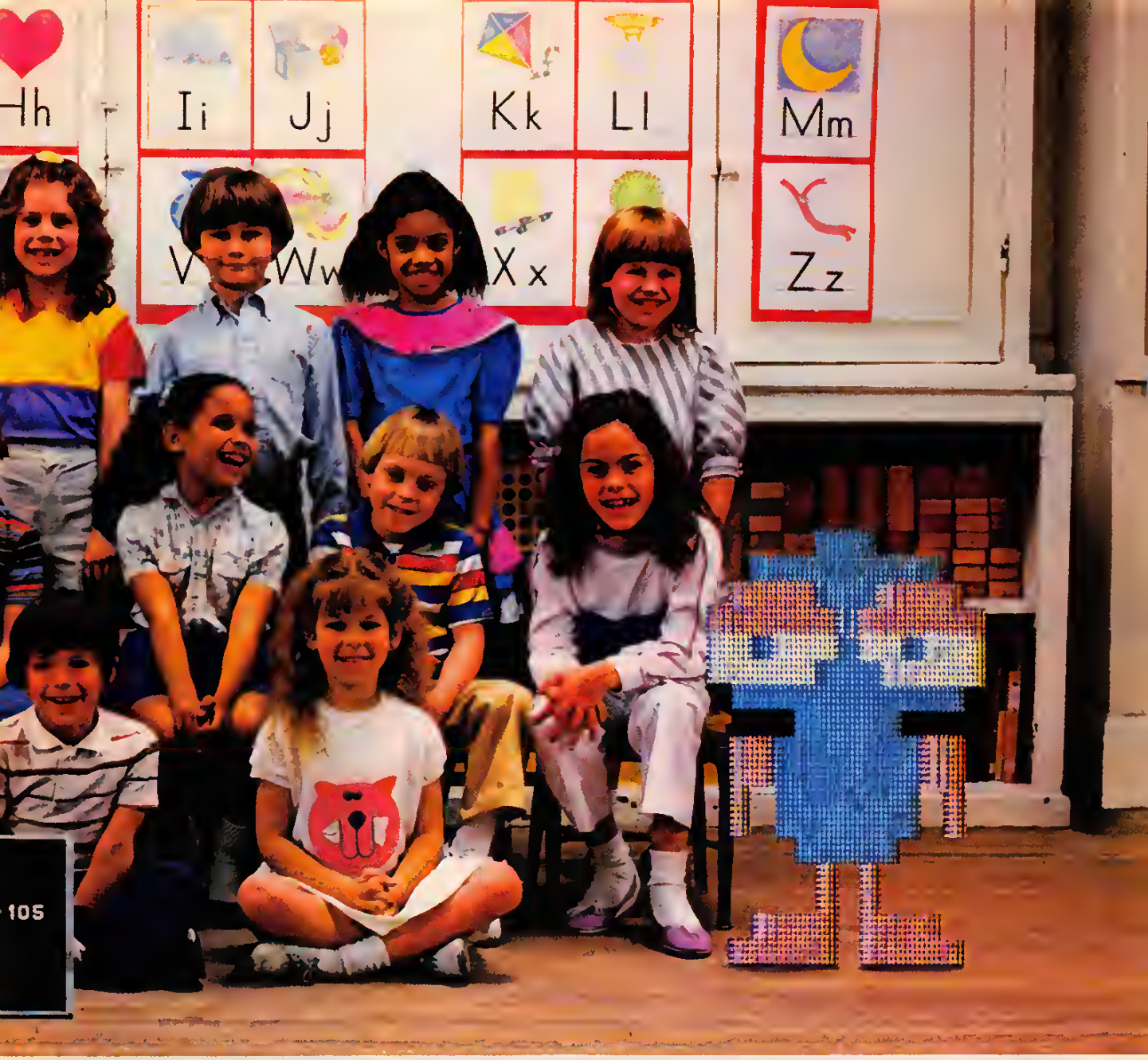

d a new breed of teachers.

variations and many decisions to make.

Knowing how to do all this isn't something Sprout learned overnight.

You see, we've got a hundred years of experience to lean on. (Our parent company is SFN, the country's #1 textbook publisher for elementary and high schools.)

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With TINK!TONK!™ software, kids see that learning can be more fun than destroying space creatures.

Compatible with Atari® Commodore® Apple® and IBM®

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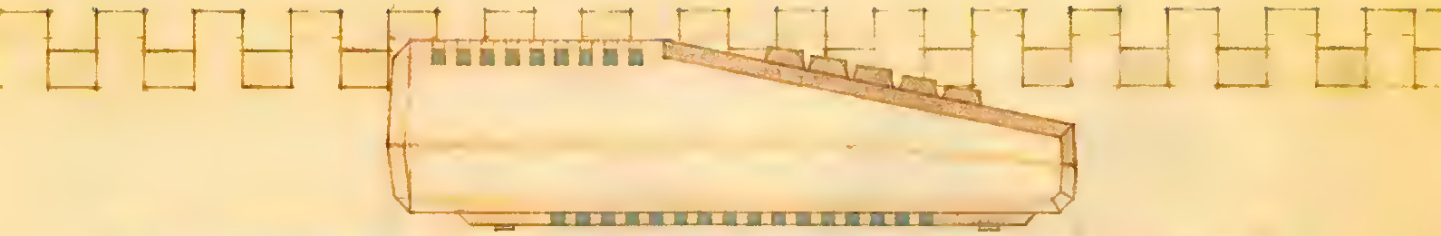

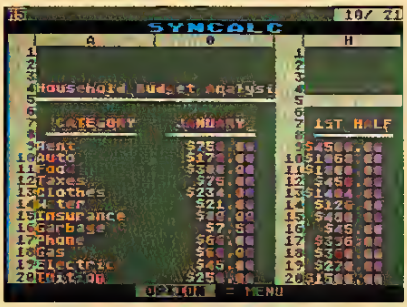

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SynCalc™

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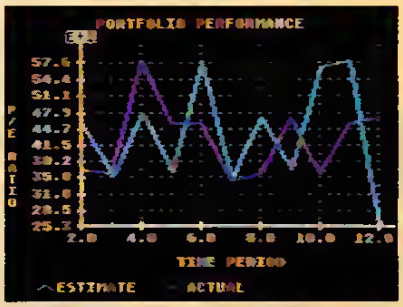
SynFile+™



Graphing and statistics
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Now your Atari computer gets down to business.

If you're a serious home manager, a student, or run a small business at home, now you can get sophisticated, integrated software for your ATARI computer with the same features as the more expensive IBM and Apple packages.

SynCalc makes a spreadsheet more manageable.

First, there's SynCalc, the most advanced spreadsheet program ever created for ATARI Home Computers. Not only does SynCalc help you get all your numbers down easily, it also comes with a sorting feature, and the ability to label and name your formulas like "beginning inventory + goods purchased−goods sold = inventory on hand," as well as standard entries. And SynCalc also comes with "expert" commands, to use once you've become more familiar with its procedures. Plus many other features found in the more expensive programs.

SynFile+ keeps information more organized.

SynFile+ can function as your database, your filing system. With SynFile+, you can reorganize and sort parts or whole files instantly. Not only can you enter text, you can calculate and update data as well. And files from both SynCalc and SynFile+ can also be used by the ATARI word processor, AtariWriter,™ for uses such as mail merge.

SynTrend gives you a more graphic way to look at data.

Next, there's SynTrend, which can be the graphing and statistical arm of your operation. SynTrend allows you to visualize your data from SynCalc or SynFile+ with either bar graphs, pie charts, line graphs or scatter plots. To do statistical analysis, you can quickly calculate means and variances, standard deviations, or even linear and multiple regressions. It's pretty easy to understand, eh? And also pretty easy to operate because all three programs come replete with easy-to-understand "pop-up" menus, to take you through their paces step by step. And remember, all three programs can share data, which helps you get the job done even faster.

So get down to business with SynCalc, SynFile+, SynTrend, developed exclusively for ATARI by Synapse. And see for yourself why the cost of taking care of business doesn't have to put you out of it.

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September 1984 Vol. 6, No. 9

FEATURES

EDUCATION AND RECREATION

REVIEWS

COLUMNS AND DEPARTMENTS

THE JOURNAL

NOTE: See page 69 before typing in programs.

GUIDE TO ARTICLES AND PROGRAMS

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AP Apple **AT** Atari, **P** PET/CBM, **V** VIC-20, **C** Radio Shack Color Computer, **64** Commodore 64, **TS** Timex/Sinclair, **TI** Texas Instruments, **PCjr** IBM PCjr, **PC** IBM PC, **AD** Coleca Adam, *All or several of the above.

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EDITOR'S NOTES

We recently received a letter from a long-time subscriber that thoughtfully raises some concerns about the present composition of COMPUTE!. It is excerpted and addressed here.

"Dear Mr. Lock,

I felt compelled to write to you to express my feelings about the disappointing changes which have been coming over my once favorite magazine, COMPUTE!. I have been reading COMPUTE! since January 1981 and have a subscription which is paid through August 1985.

In recent months, since January 1984, you have been 'spread too thin' by attempting to cover so many types of computers that I feel none have been done adequately. The technical content of the magazine, for the Commodore computers, and computer use in the home, is what had interested me the most, and the quantity and the quality have dwindled so much . . .".

Our reader goes on to discuss concerns in specific about the breadth of our articles, and the size of our columns. We thought this presented a good opportunity to address these concerns and hopefully explain some of what we see happening from here, and where it will take us.

The Case Of The Dwindling Magazine

In December of 1983, COMPUTE! had 392 pages. This issue, September 1984, has 160. The December issue had 215 pages of advertising; this issue has 60.5. During the course of 1984, we've seen a massive shakeout, not unexpected of course, in the industry. Where there once was an advertiser base of thousands of companies, there is now an advertiser base measured in the hundreds. All well and good, you may say, but is it really a problem or concern for you, the readers? In the sense that we must attend to some economic realities in planning and publishing our magazines, the answer is yes. Do we subjugate our concerns to formula? No, absolutely not.

A typical rule of thumb for the publishing business is a 50/50 advertising mix. As size increases, this ratio gives over to an increased percentage of advertising. In our case, the December 1983 issue of COMPUTE! was over 55 percent advertising. The September issue, by rule of thumb, should be at most 128 pages. Given the overhead we carry in fixed page content (i.e., everything from columns to MLX), this was not acceptable. The result is that our editorial percentage in this issue approaches 65 percent.

The Future

Certainly all of this makes sense, but it still doesn't solve the problem/question at hand: more content. What else can we do? We're working on it. In our "fixed overhead" areas, we're whittling down column sizes. We're trying to expand the scope of some columns so they're more useful to more of you. And we're evaluating all of our columns with an eye toward further reductions.

One of your complaints, in essence, is that some of the "meat" of our content is diminished. Upon reflection, I think that's an offshoot of our attempts to provide continued breadth. We probably have a tendency to run shorter articles to enhance variety. The unfortunate by-product of this is that some of the more technical, lengthy articles are bypassed. This we can address immediately, and we will begin to do so with our October issue. We would welcome some additional input from readers. One suggestion here has been that we start to run some of our "fixed" material on an every-other-issue basis. This would mean that "Beginner's Guide To Typing In Programs," for example, might appear on alternate months. We are open to your thoughts. Your comments?

Editor In Chief

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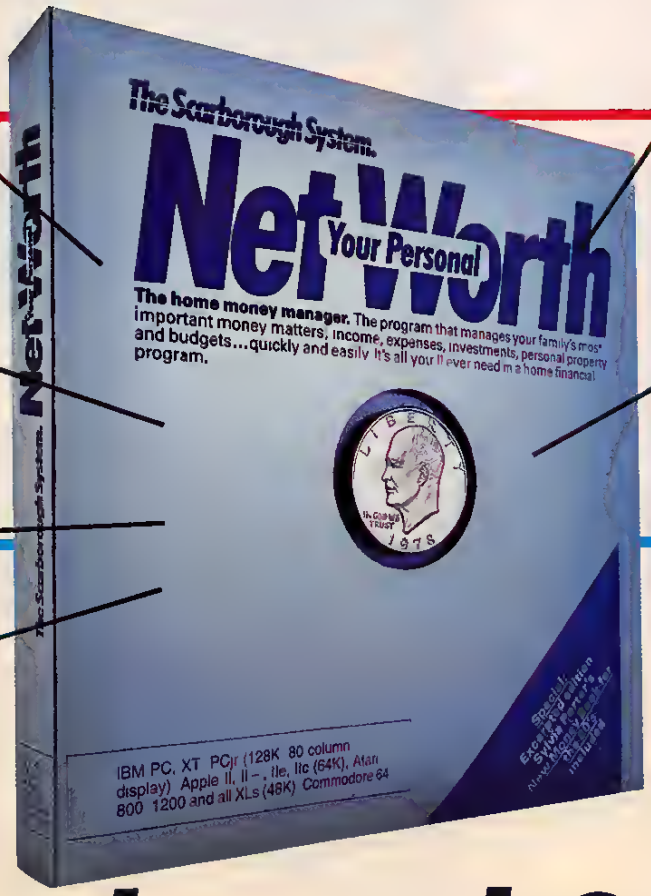

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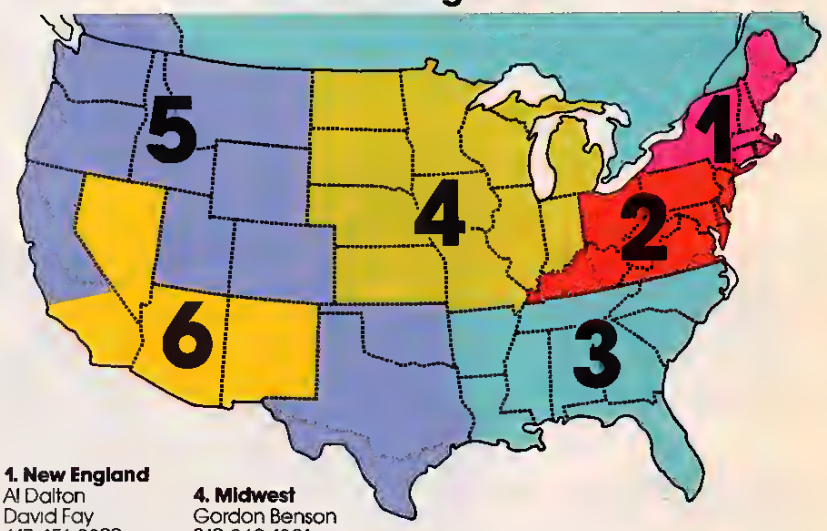

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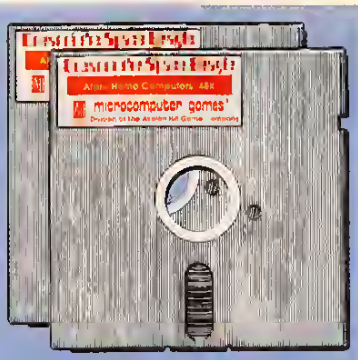
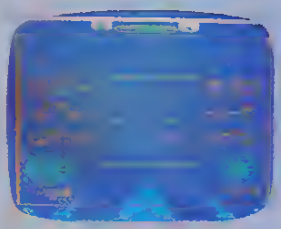
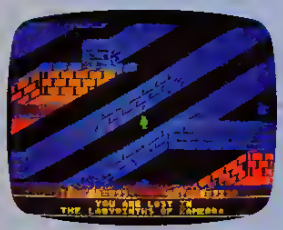


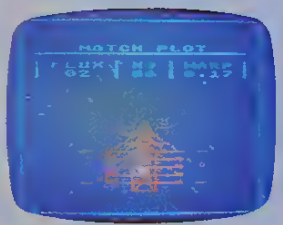
Scott Lamb's Interactive Space Fantasy Adventure



Space Battle Display



The Labyrinths of Kamerra



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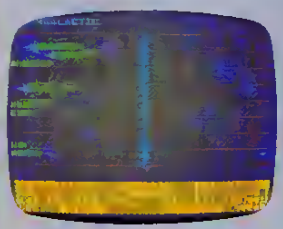

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■ Befriended by the Faunians, a peaceful race being invaded by the evil Gentuzians, they have decided that YOU must launch a pre-emptive strike against the Gentuzian homeworld. You must command 10 Faunian robot fighters against the Gentuzian battle fleet which outnumbers you four to one! It won't be easy; you'll need the right tactics and all the skill and patience you can muster.

■ Assuming you are successful and conquer the Gentuzians, they will want you to become their Emperor. The only thing you want is to repair the Space Beagle and get back home. But they are insistent creatures; refuse the crown, and you can forget leaving. Reluctantly you accept and, to prove your claim, they drop you into the Labyrinth of Kamerra! Find your way out, and they'll let you go home as Emperor of Gentuza. No problem, you think, until you soon realize that Kamerra is a cruel maze deficient of adequate food and oxygen, yet aplenty with dangerous pits and "Ardillian Whipstingers."

■ SHOOT THE STARS! Fortunately, you are able to save your game in progress every step of the way in **QUEST OF THE SPACE BEAGLE**.

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Automatic Conversions?

Many of the programs you publish in COMPUTE! are for several different microcomputers. Do you have utilities that automatically convert a program to another type of computer? Are they available for sale?

J.B. Allen

We call the process of converting a computer program to another computer homogenization. *Unfortunately, we do not have, nor have we seen, any utilities that will automatically homogenize a program.*

We have a staff of talented programmers that manually goes through programs and homogenizes them. The process can be a laborious one, particularly with machine language programs which often require a byte-by-byte translation.

Missing Commodore Ribbons

I am the owner of a Commodore MPS-801 printer. Until recently, I have had trouble finding a replacement ribbon. It seems that the dealers selling the printers are not able to get the ribbons.

I have some good news for you to pass on to your readers. You can find a replacement ribbon at your local Radio Shack store. It is the ribbon for the DMP-110 printer, part number 26-1283. This ribbon is identical to the one for the MPS-801 printer.

Frank W. Fife

Many readers have mentioned difficulty locating replacement ribbons for the 801. Thanks for the tip.

Atari Monitor Hookup

I have ordered a BMC monitor and an Atari 800XL. Very recently, I was told that the Atari is designed for use with a standard TV set. How can I make the Atari work with the BMC monitor. Will the monitor be totally useless?

Benedict V. Sulit

Although optimized for use with a television set, the Atari 800XL looks even better on a composite color monitor. You can also hook up a black-and-white (monochrome) monitor. You'll need a special cable that plugs into the round, five-pin DIN plug on the back of your 800XL. For a color monitor, get a cable that feeds the chroma (composite video) signal into Video In on your monitor. For a monochrome screen, you'll get best results using the LUMA (luminance) signal. Some cables bring out all five pins to RCA phono jacks. With trial and error you can easily find which wire controls which signal. You can get a video cable at your local computer store or possibly a TV/video store.

Musical Apples

I am an Apple IIe user and would like to know how to program my computer to make music. Can you do it in Applesoft BASIC or do you need another language?

Denny Hays

It's a fairly simple matter to make elementary sounds on the Apple in BASIC. You can tweak the speaker by accessing location −16336 (i.e., POKE −16336,0) or ring the bell by PRINTing CHR$(7). But to do much more than this, you need a short machine language (ML) routine. Fortunately, this ML routine can be POKEd in from BASIC.

You can find such an ML routine in an article by Blaine Mathieu (COMPUTE!, *October and November 1983). The tutorial explains both fundamental and complex Apple sound generation.*

More Open Commodore Files

The "64 Explorer" by Larry Isaacs in the March 1984 issue concerning the maximum number of files which can be open at one time on the 1541 disk drive caught my interest. I have discovered some further information.

The number of sequential files opened for writing can be increased to three if the filename is prefixed with a *0:*. When this is not the case, the drive acts as Isaacs described.

Since the Disk Operating System was originally used on a dual disk drive, I always add the prefix *0:* to any disk operation to insure that it will work properly.

Mitchell S. Comstock

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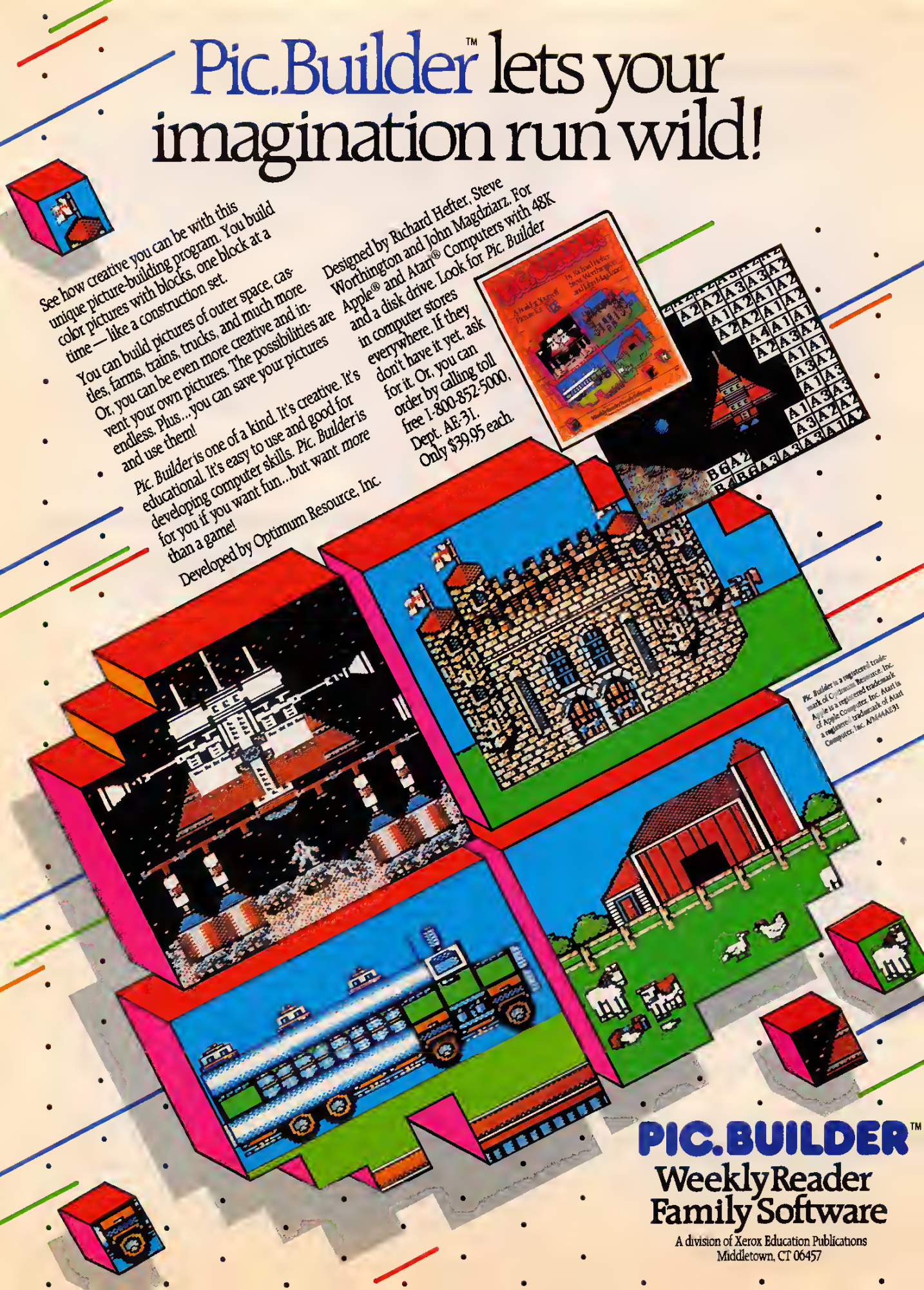

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Autobooting Atari

Is there any way you can make a program run right after it has been loaded into your computer from tape or disk? This would prevent anyone from seeing the special codes in the program.

Mark Zobel

We assume you are using a password or are disabling the break key and system reset. If the program didn't run automatically, anyone could LIST the program and remove the protection. Although you can't completely bar an experienced, enthusiastic invader, you can make a program run automatically from disk when you boot up your system. See "Automate Your Atari" in COMPUTE's Third Book of Atari.

Although it is possible to create a boot tape that does the same thing, we don't know of a specific program. There are techniques for making BASIC programs RUN automatically when LOADed on Commodore machines (for example, having the program load in memory low enough to change some vectors), but the technique is too involved to cover here. See "Commodore Autoboot" elsewhere in this issue.

TI Memory Maps

I write this in reply to the letter from Davin A. Trulsen in the May issue of COMPUTE!. If he or any other TI user wants a comprehensive memory map for the TI, they should write to Miller Graphics, 1475 West Cypress Avenue, San Dimas, CA 91773. Miller Graphics offers a monthly newsletter, called *The Smart Programmer*, for $12.50 a year. They have published four so far and I have found them quite useful.

Bill Grant

Incomplete NEXTs

I have a VIC-20 and I have a question about the NEXT statement. I've seen some programs that had a NEXT statement with nothing after the next. For example:

```
FOR A=1TO10:NEXT
```

Why doesn't it include the variable after the NEXT as in:

```
FOR A=1TO10:NEXT A
```

Kevin Biebor

The NEXT statement increments or completes a loop that was started by a FOR statement. If a variable is placed after the NEXT, that loop is incremented. In the following example, the B loop will be incremented (and completed) ten times each time the A loop is incremented.

```
FOR A=1TO10
FOR B=1TO10
NEXT B
NEXT A
```

If the NEXT statement is not followed by a variable name, the loop completed will be the one most recently started. In the following example, the NEXT will complete the B loop even though the A loop was the first one started.

```
FOR A=1TO10
FOR B=1TO10
NEXT
```

Nested loops *(loops within other loops) should be written with care. If they're programmed incorrectly, one or more of the loops may not be completed. For instance, the B loop in the following example will never be completed.*

```
FOR A=1TO10
FOR B=1TO10
NEXTA
NEXTB
```

Don't Blame The Hardware

I am having a problem reading arrays on the Atari. This simple program is an example:

```
10 DIM X(5)
20 FOR I=1 TO 5
30 READ X(I)
40 PRINT X(I)
50 NEXT I
60 DATA 3,5,-2,7,4
```

I always get an error in line 30. I wonder if my computer memory has gone bad.

Lloyd R. Holmes

When faced with a particularly stubborn bug, most programmers start to suspect the hardware—but it's almost never the culprit.

As a general programming rule, never *assume the hardware is bad except as a last resort. Some program bugs are so obscure, so hard to track down, that it becomes pretty tempting to blame the hardware. Nevertheless, true hardware errors almost always exhibit outrageous behavior, such as lockups when you turn the machine on, screens that suddenly go haywire, an eerie, inexplicable hum when you use SOUND, etc. Hardware errors are obvious, except when just a few bytes of RAM go bad. You can buy memory test programs, but it would probably be an unnecessary investment.*

The specific problem you're having here is syntactic. On the Atari, you cannot READ a data item directly into an array. READ X(I) is just as illegal as INPUT X(I). It's a lamentable eccentricity, but it is easy to get around. Just read the item into a temporary variable, then assign that variable to X(I). To wit: READ T:X(I)=T.

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And remember The Programmer's Debugging Rule: Hardware problems are as obvious as they are rare.

Commodore Plus/4

Since you published the article on the new Commodore computers (COMPUTE!, April 1984), I have been giving serious thought to purchasing one. I will be enrolling in college, and feel that the new Commodore 264 would be a good choice for my major: electronics. However, I have a number of questions about the 264.

1. I know that the 1541 disk drive works with the Commodore 64 and the VIC-20, but will it also be compatible with the 264?
2. How far can I expand the RAM or ROM memory in the 264?
3. Can I buy an Eprom burner for the 264?
4. Is there any software available for the new 264?
5. Is it possible to increase the baud rate of the 1541 disk drive?

Don Maxwell

The new Commodore Plus/4 (renamed from the 264) has not been released for sale as of this writing. It is, however, expected to hit the retail shelves sometime this fall.

About the same time, Commodore is planning to market a new disk drive, the SFS-481. SF stands for super fast *because it has an advertised baud rate of 1675. However, a 1541 disk drive will be compatible with the new Plus/4 as well.*

Although the Plus/4 will support (memory) bank switching, Commodore has not announced any memory expansion for the Plus/4. However, third-party companies might eventually offer something.

Regarding EPROM burners, again Commodore has no current market plans, but undoubtedly third-party manufacturers will offer this peripheral. Also, there will be software available for the Plus/4. There already exists a considerable amount of both application and entertainment software.

As to the baud rate change on the 1541 disk drive, a Commodore representative said that the baud rate (the speed that information is transmitted to or from the disk drive) on the 1541 cannot be changed on the drive as is. The current baud rate is dictated by the serial port interface on the computer. In other words, no matter how you modify the disk drive, the computer will only be able to receive data at its preprogrammed rate.

The 1541's rate can be increased by converting it to a parallel interface. But this is a major engineering project, and might prove to be both impractical and costly.

Buying The Right Modem

I am thinking of buying a modem. Do I need a rotary-dial phone, or will modems work with a Touch-Tone system?

Steve Milewski

Most modems will work with both the Touch-Tone and the older rotary phones. Some modems, in fact, work on Touch-Tone phones by emulating the rotary system. The Commodore 1650 auto-dial modem is one.

Before buying, however, it's always best to ask your dealer, or call the modem manufacturer for further information.

Commodore Service

I am an electronics repair technician, and own a Commodore 64. I cannot find anyone in my area who can repair my computer.

Where can I obtain the technical information to service my Commodore computer, and all of its related peripheral equipment?

Gordon Bates

The addresses and phone numbers of the Commodore service centers are as follows:

1200 Wilson Drive
West Chester, PA 19380
(215) 431-9105

2246 North Palmer Drive
Schaumburg, Il 60195
(312) 397-0075

4350 Beltwood Parkway South
Dallas, TX 75234
(214) 458-1000

3330 Scott Blvd.
Santa Clara, CA 95051
(408) 727-1130

Technical information on some of Commodore's products is also available. They offer packages which include schematics, technical information, troubleshooting instructions, etc. For price and availability information, contact the parts department *at the West Chester, PA, address listed above.*

Cassette Filenames And Built-In BASIC

I own an Atari 400 computer. Can you specify a filename for the 410 program recorder? Also, how do you run a program that asks you to remove the BASIC cartridge on the 600XL? Since BASIC is built-in, it seems like it might be impossible.

Doug Stevens

The tape operating system could have been written to allow filenames, but since tape access is sequen-

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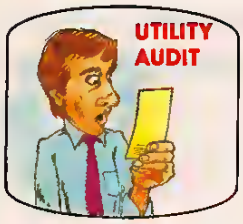

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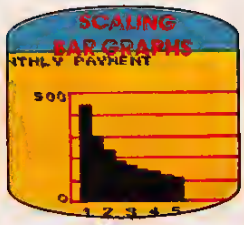

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tial and so slow compared to a disk drive, filenames are not especially useful. You can instead use the tape counter to find and position programs. Be sure to leave plenty of space between programs, since the tape counter is not precise, and you could inadvertently write over a program.

Some programs require 48K, 8K of which is not available with a cartridge plugged in. These programs check for a cartridge and ask you to remove it before the program will run. The 600XL has only 16K, though, so this shouldn't be a problem. In any case, you can effectively remove (disable) the built-in BASIC by holding down the OPTION key while you turn on the computer.

6502/6510 Differences

I am a relatively new computer owner and I want to learn machine language programming. As far as I can tell, my Commodore 64 contains a 6510 chip rather than the more common 6502.

A phone call to Commodore's corporate offices revealed that the machine language for the two chips is not compatible. The *Programmer's Reference Guide* directs all its instructions to the 6502 processor.

I am unable to find anything in print on machine language programming using the 6510. I would appreciate it if you could help me out. Are the two chips incompatible? If so, can you tell me how and where I might learn machine language for the 6510?

Dean Lind

Unfortunately, the representative you talked to at Commodore was misinformed. The 6502 and the 6510 microprocessors are compatible. Both use the same instruction set (LDA, STA, etc.) and addressing format (low byte, high byte). Books on programming the 6502 also apply to the 6510.

The only major differences between the two processors are bytes one and two of the 6510. The 6510 allows you to bank switch *memory.*

The Commodore 64 has 20K of ROM, including the BASIC interpreter, Kernal, and Input/Output control programs. There is also 20K of usable RAM memory "underneath" this ROM memory. You can switch out the ROM and switch in the RAM memory by bank selecting blocks of memory. If you wished, you could turn your 64 into a computer with 64K of usable RAM memory by switching out all of the ROMs. However, you would have to supply your own BASIC interpreter, operating system, and I/O control programs. Without these, the computer would simply freeze, and you wouldn't be able to write or run BASIC or machine language programs. For more information on bank selection, *refer to your* Programmer's Reference Guide.

The VIC-20, which is equipped with the 6502 microprocessor, does not support bank selection of ROM/RAM memory.

A book on 6502 machine language programming will apply to the 6510. You might also want to take a look at the "Machine Language for Beginners" column in COMPUTE!'s GAZETTE, *our sister publication.*

Printer Device Number Changes

Is it possible to change the device numbers of a printer? I want to buy a second printer for my computer, but am unsure if I can use both printers at the same time.

Jacques Poulet

Usually the device number cannot be altered. It depends on the brand of printer, but most printers have no significant internal "intelligence" (no computer assistance inside). You could change the device number of a disk drive because it can be programmed from the computer; it is an intelligent *device.*

However, some models of printers do allow you to change device numbers via a switch on the printer itself. The new Commodore MPS 801, for example, has a three-position switch that allows you to choose between device numbers 4, 5, and 6. And some few printers can be software assigned.

DIM On Commodore

What happens to the data when it enters a DIM statement (array) from an INPUT statement or a sequential file?

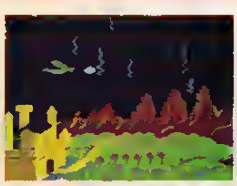
I teach computer programming part-time at Tulsa Junior College. This is my first semester with micros. I have a Commodore 64 and a VIC 1541 disk drive. In advanced BASIC, sequential files are common, and are usually used for search and sort routines. When the data is read from DATA statements into the arrays, there is no problem. The sort or search never stops, but when that same data is brought into the arrays from a sequential file, the sort or processing stops many times, making a 16 to 30 minute program run for hours.

I have written my own sequential file program, and later discovered and used the one off the demonstration disk that came with the VIC 1541 disk drive. Both have these stops. I have tried about everything. If you could give me a clue, I would appreciate it.

Darrel Henry

The pauses you see in the program are the result of a process called "garbage collection." It's caused by moving strings around.

DRAGONRIDERS OF PERN.
FLY THE UNFRIENDLY SKIES.



Shooting down the menacing and constantly multiplying Threads isn't easy, but it's only one of the challenges in this official computer game version of Anne McCaffrey's famous book series.

Your strategy will be put to the test as you try to negotiate alliances with Pern's Lord Holders in an attempt to form the most powerful Weyr on the planet. Should you take a firm stance or compromise? Will asking a Craftmaster for assistance increase your chances for success? Maybe you should invite prospective allies to a Wedding or even a Dragon Hatching. Remember to check the Lord Holders personality traits first. It may be critical to your success.

Numerous screens combine to create truly unique and challenging game play. There's even a practice screen to sharpen your Thread Fighting skills.

If you liked the books, you'll love the game. After all, how often do you get the chance to actually fly a dragon?

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Here's what happens: As new strings are created, the old ones are not thrown away; they lie dead in memory. Eventually, memory fills up and the computer has to stop and collect the strings that are still live. This takes time; the pauses are quite noticeable and can be time-consuming.

Strings that are completely defined within a program—from DATA statements or from an assignment statement such as X$="HELLO"—are used straight out of the program where they lie. These strings don't need to be collected; as you have noted, there's no garbage collection delay when you use these.

For your type of program—sorting and searching—there are two rules that will be very helpful in eliminating delays:

1. Don't move strings. Instead of sorting by moving them around from one part of the array to another—which creates garbage—use an "index" to keep track of where a string belongs within a certain sequence. (More on this in a moment.)

2. When you have finished with a string, set it to a null string, for example, A$(21)="". When you have disposed of almost all strings this way, and are ready to read in another set of strings from disk or tape, force a collection by using the FRE function, for example, code X=FRE(0). Garbage collection will run quickly if you have very few strings left. When you read in the next group of strings, they will come into the newly liberated memory space.

To illustrate point 1: Here's a program to sort an array of strings. It's a bubble sort, which is not very efficient. The point is this: After the strings are created, they are never moved. Only the index (A%) values move, and they are numbers, not strings, so there won't be any garbage.

```
 90 REM BUBBLE SORT - INDEX DEMO
100 N=30:DIM A$(100)
200 REM CREATE RANDOM STRINGS
210 FOR J=1 TO N
220 A$(J)=CHR$(RND(1)*26+65)+CHR$
    (RND(1)*26+65)
230 NEXT J
300 REM: CREATE INDEX
310 DIM A%(N)
320 FOR J=1 TO N
330 A%(J)=J
340 NEXT J
400 REM: SORT INDEX
410 FOR J=N-1 TO 1 STEP -1
420 FOR K=1 TO J
430 REM: GET INDEX FOR K, K+1
440 X=A%(K) :Y=A%(K+1)
450 REM: FLIP IF OUT OF ORDER
460 IF A$(X)>A$(Y) THEN A%(K+1)=X:A%(K)=Y
470 NEXT K,J
500 REM: PRINT RESULTS
510 FOR J=1 TO N
520 PRINT A$(A%(J))
530 NEXT J
```

Study this program to see how the strings are sorted, but not moved.

There are other rules on how to handle garbage collection; the ones above will do the job for your application.

TI CALL KEY

I recently acquired a TI-99/4A and wondered if you would explain the use of the CALL KEY command?

David Stinchcomb

The CALL KEY statement has caused confusion for many TI users. The KEY subprogram, designed to return a single keystroke value, requires three parameters: a key unit, a return variable, and a status variable. The statement takes the format:

```
CALL KEY (n,K,ST)
```

where n is the key unit, K is the return variable, and ST is the status variable.

The key unit used in the CALL KEY statement determines the keyboard configuration assumed by the computer. Six key unit values (0–5), or keyboard configurations, are available on the TI-99/4A. The three key units generally used are 0, 1, and 2. A key unit of 0 refers to the console keyboard. Key units 1 and 2 map the console keyboard as split keyboards (a value of 1 to read the left side of the keyboard, a value of 2 to read the right), or read the fire buttons on joystick 1 and 2, respectively.

When a CALL KEY statement is executed with a key pressed, some value will be assigned to K (in our example above). The value given to K will depend on the key pressed and the key unit used in the CALL KEY statement. If you use a key unit of zero, K will correspond to the ASCII value of the key being pressed. For other keyboard configurations, the value of K will vary as noted in the TI User's Reference Guide *(pp. II-87 to II-89). Eighteen in K signifies that the fire button was pressed.*

The final parameter used in the CALL KEY statement is the status variable (ST). A nonzero value returned for ST indicates that a key was being pressed when the CALL KEY statement was executed.

CALL KEY can be used to get a desired response from the program user. If you want to test for any keystroke (with key unit 0), you would use the following two lines:

```
10 CALL KEY(0,K,ST)
20 IF ST=0 THEN 10
```

The program repeatedly loops back to line 10 until some key is pressed.

If you want the program to accept only a specific response from the user, such as Y for "yes," you could add these lines:

```
5 PRINT "TYPE THE Y KEY"
30 IF K<>89 THEN 10
```

Until the Y key is pressed, the program will loop back to 10.

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Commodore Machine Language Clear

I have been trying to develop a monitor program for the VIC-20 and am having a difficult time creating a routine to clear the screen. Is there any way to clear the screen without getting the READY prompt?

Stan Payne

There are several ways to clear the screen from machine language. The easiest way is to assemble the following:

```
LDA  #$93   ;the equivalent of CHR$(147)
JSR  $FFD2 ;print it
```

This routine will work on both the VIC and 64. Incidentally, you can also use it to home the cursor. Just replace the $93 with $13. The hex number 93 is the same as the character that clears the screen in BASIC and $13 is the same as CHR$(19) which homes the cursor.

Another way to accomplish the same result is to assemble the following:

```
JSR  $E55F ;clear the screen and home the cursor
```

On the 64 the routine is located at a different location, thus the coding is different:

```
JSR  $E544  ; clear and home
```

If you just wanted to home the cursor on either machine you could JSR to $E581 on the VIC or $E566 on the 64. Although these are two quick, easy ways to clear the screen, there is yet another. You could write your own routine to clear the screen. The routine would need to store a $20 at every screen location. $20 is the number for a blank character.

Commodore 1541 Drive Grounding Error

In your May issue you printed a letter from Jay Elmore regarding read errors on the 1541 disk drive. After buying a drive for my Commodore 64, I discovered that it was giving me error 23 and 27. Both are read errors. I returned the drive to the dealer and he tested it on a 64 and discovered no problems with it. I took the drive back home and carefully read the manual that comes with it and discovered that errors 23 and 27 can be caused by grounding problems. I checked the electrical outlet where the drive was plugged in and discovered that the ground plug was not properly connected. After fixing this, I haven't had any problems with my drive.

Ron Restivo

COMPUTE! welcomes questions, comments, or solutions to issues raised in this column. Write to: Readers' Feedback, COMPUTE! Magazine, P.O. Box 5406, Greensboro, NC 27403. COMPUTE! reserves the right to edit or abridge published letters. ©

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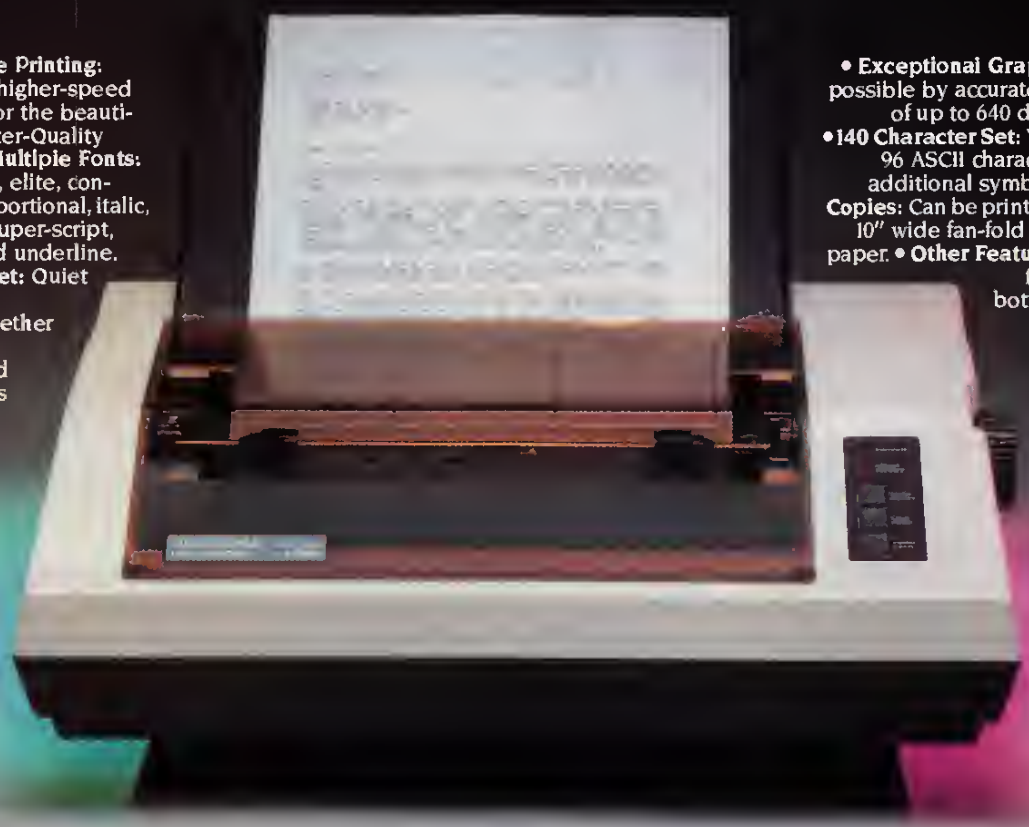

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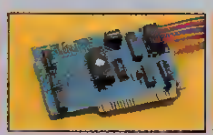

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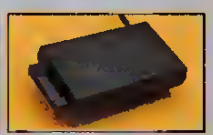

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David D Thornburg, Associate Editor

Discovery-Based Learning And Teenagers

On the Saturday before the Summer Consumer Electronics Show in Chicago, I was speaking at a Logo workshop in northern California. Much of the emphasis in one of my talks was on the importance of discovery-based learning for all ages, not just for the child in elementary school. While I have been emphasizing this topic in my talks for several months, most people seem content to let Logo be a tool for the younger computer user.

Educational Software

As I drove to the airport to catch my plane to Chicago, I wondered if this reluctance to bring the power of educational environments like Logo to older students was also evident in other educational software. After all, the mention of educational software usually conjures up visions of activities for the younger child. Whether these activities are drills associated with a specific subject or are open-ended activities designed to teach problem-solving skills, the fact remains that only 2 percent of the current educational software appears to be directed to teenagers. Some people might argue that, once a child has entered the teenage years, educational software isn't needed. If a teenager wants to use a computer, why not just let him or her write programs.

In fact, there are several reasons why teenagers should have access to good educational software:

1. Teenagers are in the process of forming career decisions. Controlled exposure to computer environments can demonstrate the richness of this field in a way that transcends purely recreational applications of computers.

2. For those students who are already interested in computers, computer-based instruction in problem-solving methods and the development of programming style can help these students use computers more effectively in their jobs.

3. Students of all ages benefit from becoming better problem solvers. So much of our focus has been on problem-solving software for the young (including such excellent programs as *The Factory* by Sunburst) that we can easily lose sight of the fact that the acquisition of problem-solving skills is important for learners of all ages.

To see what *can* happen to educational software for teenagers, we should first look at the other two areas where these children use computers—at home and at the arcade.

Interactive TV

As I look at popular computer activities in homes and arcades, there seems to be a major distinction emerging between the two. Arcade software has continued its focus on coordination and skill games. As the technology has advanced, these games have become more sophisticated. For example, several popular games use computer-controlled video disks. Except for advances in technology, however, these games seem to be stuck in a niche that one might characterize as interactive television.

Popular home software has taken a different approach. The home user is not able to run out and buy new technology every three months or so, and the challenge has thus been to make the existing technology become ever more useful

David Thornburg is an author and speaker who has been heavily involved with the personal computer field since 1978. His main interest is in making computers responsive to people's needs. He is the inventor of the KoalaPad graphics tablet and is the author of nine books about programming including Computer Art and Animation: A User's Guide to Atari Logo, The KoalaPad Book, *and* Exploring Logo Without a Computer *(Addison-Wesley). His* 101 Ways to Use a Macintosh *will appear soon from Random House. He has been called "an enthusiastic advocate for a humanistic computer revolution," and his editorial opinions have appeared in* COMPUTE! *since its inception.*

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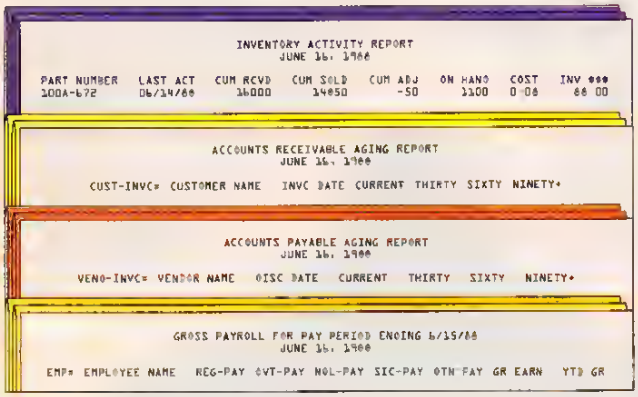

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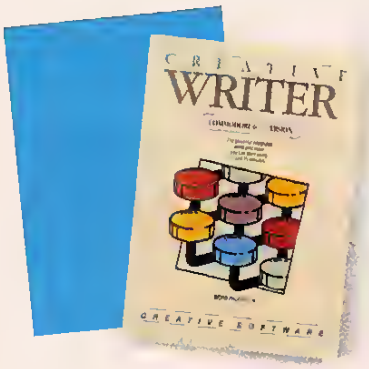

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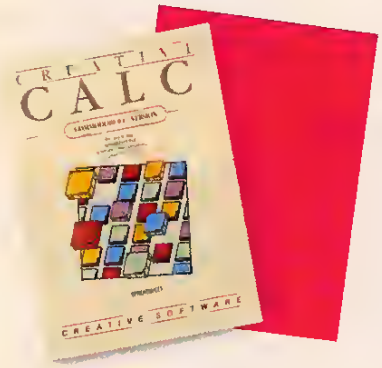

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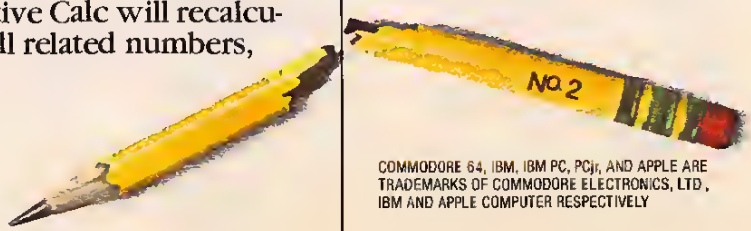

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S O F T W A R E

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with each new wave of products. While it is true that popular home titles continue to stress entertainment value, the most popular computer games appear to be those that let the player create his or her own levels or game fields. Anyone who doubts this need only look at the overwhelming popularity of Brøderbund's *Lode Runner*. Every *Lode Runner* enthusiast I know spends most of the game time creating new levels to play.

The Fourth Generation

The popularity of construction set software is not new, as readers of this column know. Programs like *Pinball Construction Set* (Electronic Arts), *Rocky's Boots* (The Learning Company [TLC]), and *Dancing Bear* (Koala Technologies) have been popular largely because they allow the user to make unique creations within the context of a predefined activity. The task of creating new games in *Lode Runner* or *Pinball Construction Set* is, quite simply, the task of creating a computer program. Construction sets are examples of fourth generation programming languages, and the fact that these programs are so popular in the home market is quite heartening.

These programs are helping their users develop problem-solving strategies and other higher-order thinking skills. Since they can (and are) developing these skills at home, they should probably also be able to develop them at school as well. Unfortunately, some teachers can't see past the game aspects of these programs, and have thus banned them from the classroom. This makes as much sense as banning humorous literature from the English classroom. Teachers should look for the deeper significance in the newer computer games.

With this background in mind, I walked through the massive computer exhibits at the CES looking for some sign of educational software that would appeal to the entertainment and cognitive skill levels of the teenage user. Not surprisingly, I found the answer at the home of *Rocky's Boots*—TLC. Long known for their support of the young computer user, TLC decided to create a product for the older child. The result of their effort is *Robot Odyssey I*, an entertaining adventure game that is also a sophisticated programming language. As the first product in TLC's "DigiWorld" series, it represents a significant contribution to open-ended educational software geared to the teenage (and older) market.

Players begin by falling into Robotropolis, a futuristic underground city inhabited by robots. The object is to escape this world and return to civilization. This is accomplished by constructing robots that help the players work their way upward through several layers of this underground city. Each layer has new obstacles and antagonists that require robots with different skills to help in the escape. As players get closer to the top, the challenge becomes more difficult.

Complex Circuitry

What distinguishes *Robot Odyssey I* from other multilevel adventure games is that the player must construct robots that are programmed to display certain behaviors needed to avoid or neutralize obstacles. The task of creating these robots involves learning how to "wire" the robots to perform certain tasks. A special environment called the Innovation Lab lets the player work on robot design. There are three robots at the player's disposal. Each robot resembles a spaceship and has four thrusters to move it in four directions. The robot also has a claw that can be used to pick up things, and bumpers to tell when the robot has bounced against a wall or other obstacle. By interconnecting the bumpers with the appropriate thrusters, the player can create a robot that solves simple mazes.

More elaborate programs can be created with the aid of integrated circuit chips built from standard logic elements (AND, OR, XOR, etc.). Once an array of these elements has been interconnected and brought to the desired pins on the chip, the resultant circuit is burned into a final chip that can be carried inside a robot to be connected with the rest of the circuitry. Amazingly, a finished chip can be carried inside another chip, and this recursive nesting can take place up to 40 times. This allows the creation of quite complex circuits.

Intelligent Robots

Each of the three robots becomes, in effect, a fully programmed entity. All three robots can carry out their tasks simultaneously. This is like having a word processor, a spreadsheet program, and a videogame running on your computer at the same time. But one of the neatest aspects of these robots is that they can send messages to one another using their antennae. For example, each robot could be programmed to look for fuel crystals. As soon as one robot finds a crystal, it can send a message to the other robots to stop looking for fuel and to find the first robot instead. This type of programming in which computational objects send messages to each other is reminiscent of the sorts of things one expects from Smalltalk, LISP, or Logo—not the sort of thing one expects from a videogame.

To properly explore *Robot Odyssey I* would take far more space than I have. Suffice it to say that if teenagers have only 2 percent of the educational software, this program shows that they won't need much more. ©

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Questions Beginners Ask

Tom R. Halfhill, Staff Editor

Are you thinking about buying a computer for the first time, but you don't know much about computers? Or maybe you just purchased a computer and are still a bit baffled. Each month in this column, COMPUTE! *will answer some questions often asked by beginners.*

Q How long does a floppy disk last? If I have some disks that are more than a year old, should I copy them onto new disks? How can you tell if a disk is wearing out?

A The lifetime of a floppy disk largely depends on how heavily it is used and how carefully it is handled.

It's doubtful that you would actually wear out a disk with normal home use. One well-known manufacturer of floppy disks (3M-Scotch) guarantees its products for 3.5 million passes per track. 3M calculates that if you updated the disk (rewrote every track) once every hour, it would take more than 200 years to exceed 3.5 million passes. Not many home computer owners would use a disk that heavily. Some disk-intensive business programs which run 40 hours a week might approach that many passes in much less time than 200 years, in which case an alternative should be considered—perhaps a hard disk or a RAM disk. But the casual or moderate user has little to worry about. At COMPUTE! we have some disks that get fairly heavy use for storing word processing files, and after two years they're still going strong.

A floppy disk's lifetime can be drastically shortened, however, if it isn't handled and stored correctly. In careless hands a disk might not even last ten minutes. Disks are particularly vulnerable to magnetic fields from monitors and TV sets, spilled drinks, cigarette ashes, extremes of heat and cold, heavy weights, ballpoint pens used to mark on labels, and even chemical fumes.

Unfortunately, the first clue which indicates a disk is going bad probably will be a lost program or a lost file. One day you'll confidently slip the disk into the drive and discover that a certain file won't load. That's why you should always keep at least one backup copy of important files on another disk or tape.

There is one clue you can watch for, though—if you regularly clean your disk drive's read/write head and notice one day that it's much dirtier than usual, it could mean that the magnetic coating on one of your disks is starting to flake off. It could also mean that you bought some poor quality disks.

Q On my Commodore 64, when using the command PRINT 7↑2, the computer will come up with the answer 49.0000001. Is this a bug in the computer?

A Not really. It's a rounding error caused by the way the Commodore 64 calculates exponentiation. When you ask the computer to figure 7^2, it doesn't actually multiply 7*7. Instead, it uses logarithmic tables. Rather than engaging in a long discussion of higher mathematics, let's just say that these tables sometimes lead the computer to an answer which is slightly off. If 49.0000001 isn't accurate enough for your purposes, you can either PRINT 7*7 or PRINT INT(7↑2), which extracts the integer from the result.

The Commodore 64 isn't the only microcomputer which suffers from this problem by any means. Certain math operations will result in very small rounding errors on anything from an Atari to an IBM PC. On an Atari with the BASIC cartridge, for example, PRINT 2^2 (equivalent to PRINT 2↑2 on a Commodore) comes out to 3.99999996, while PRINT 2*2 yields the correct 4. The problem was fixed with the BASIC built into the Atari 600XL and 800XL.

The quirk which leads to this kind of problem is that computers perform all of their math in binary. When floating-point (moving decimal point) numbers are converted to binary and then back to decimal, small errors can accumulate.

Q I recently found several old 60-minute cassette tapes. Are the 60- and 30-minute cassette tapes acceptable for program recording? Is there any command or program which can be used to erase these tapes? They contain music and talk.

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In *Donkey Kong Jr.*[2] by Nintendo[2], Junior tries to rescue his father against immense odds. And speaking of Donkey Kong, there's also *Mario Brothers*[2] by Nintendo[2]. This time, Mario and his brother Luigi battle creatures on four levels of floors, encountering all sorts of treacherous enemies.

In *Track And Field*[3] you can compete by yourself or head-to-head with another player. But each player must beat qualifying times, heights and distances before they can compete in each of the gruelling six events.

Typo Attack is the much-acclaimed, fun-filled program that allows you to enjoy developing your typing skills at any level.

And still playing to the delight of audiences everywhere are *Pac-Man*[4], *Ms. Pac-Man*[4], *Jungle Hunt*[5], *Battlezone*™, *Donkey Kong*[2] by Nintendo[2], *Centipede*™ and *Pole Position*[6].

So, if you've been searching for ways to entertain your Commodore, Apple or IBM, treat it to one of the best shows in town, one of the hits from ATARISOFT.

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*Titles available on IBM PC jr. are Ms Pac-Man, Centipede, Donkey Kong, Moon Patrol[7] and Typo Attack. Available on the VIC 20 is Typo Attack.

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It isn't really necessary to erase the old material on the tape before recording your programs. The recorder's erase head will wipe it out as you record. However, your letter indicates you have an Atari 400 computer. The Atari Program Recorder has a *stereo* read/write head because the Atari can accommodate an audio track that plays through the TV speaker. When you load your program, you'll hear the old audio material along with the bleeps of the data. By typing POKE 65,0 before loading the tape, the bleeps will be silenced and you'll hear the audio only.

However, if you do want to erase a tape before using it, the best method is to use a bulk tape eraser (available at electronic supply stores). Another way is to insert the tape into an audio cassette recorder, press the record button, and disable the microphone by switching it off or sticking a null plug into the microphone jack. If the recorder has level controls, turn them all the way down.

With an Atari Program Recorder, you can erase tapes by pressing the record and play buttons and typing POKE 54018,52. This switches on the cassette motor from the computer. You can turn off the motor by typing POKE 54018,60. ©

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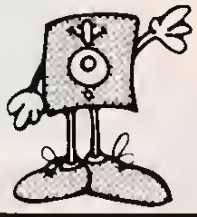

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THE BEGINNER'S PAGE

Robert Alonso, Assistant Editor

ROM And RAM

Every group has its lingo. When you first start to get used to computers, there are a few words to learn, a bit of *computerese*. Two of the simplest, yet most misunderstood, of these terms are ROM (Read Only Memory) and RAM (Random Access Memory).

Absent-Minded Computer

Read only memory is called that way because it is a kind of memory in each computer which can only be read. No matter how many times you try, you may never write in ROM. Computers come equipped with ROM because they need to have instructions that tell them how to perform certain functions such as adding or subtracting or even how to send things to disk drives or printers. The ROM memory stores these vital instructions in chips that can't be erased by writing to them or by turning off the computer. Without ROM your computer would be useful only as a doorstop. Just imagine turning your computer off and having it forget how to work the next time you turned it on.

BASIC is usually a set of machine language routines stored in several ROM chips in each computer. Another set of important ROM routines are the input and output routines. These routines instruct your computer on how to communicate with external devices such as disk drives, cassette recorders, and printers. ROMs obviously contain important routines that are needed for doing any kind of work with your computer.

Extra ROM

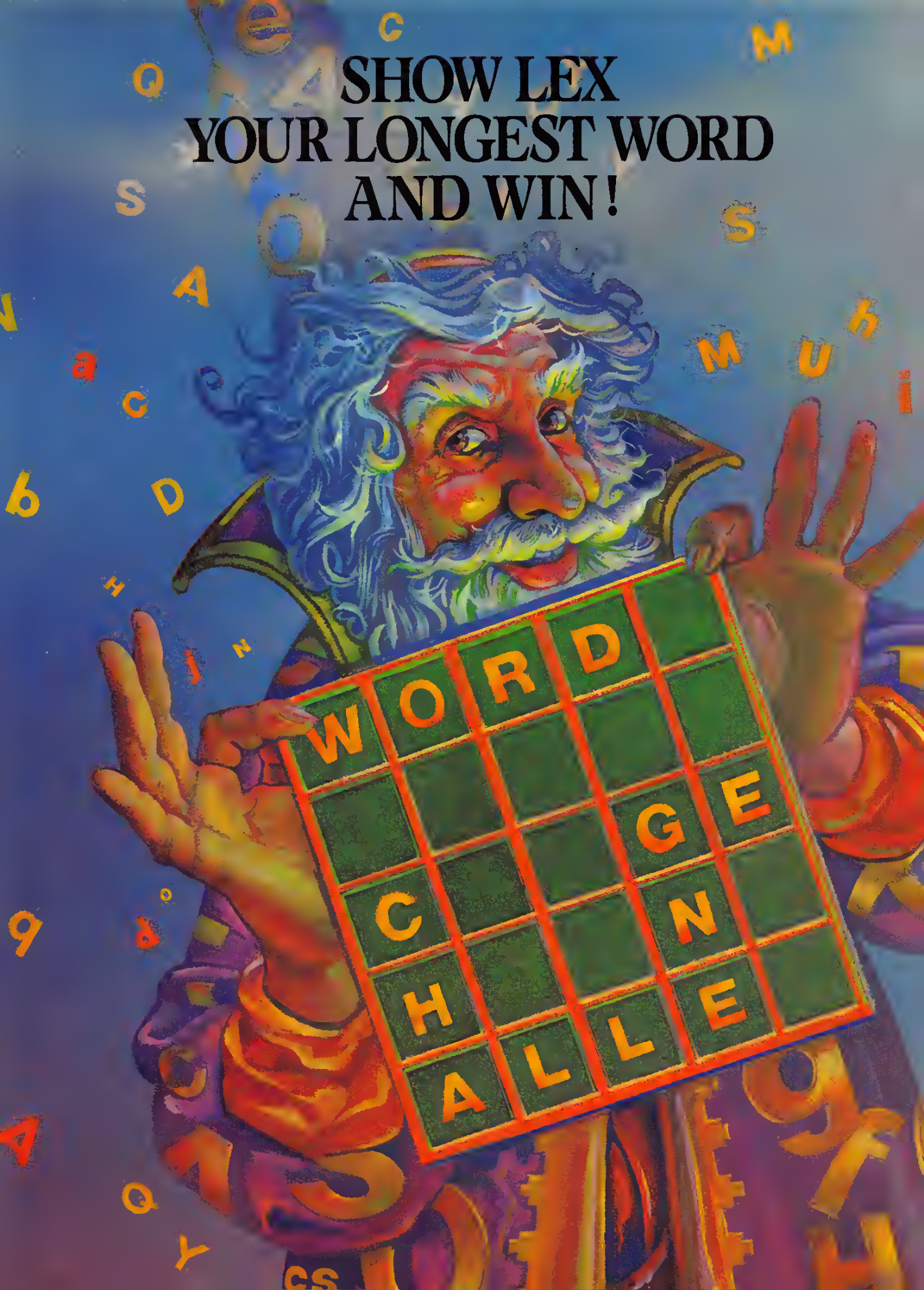
Another useful and popular form of ROM is the game cartridge. Yes, those small black boxes that provide you with so many hours of fun are just preprogrammed read only memories. These ROMs in cartridge form are perhaps the fastest way to load a program into your computer. The reason they are so fast is that usually there is no loading taking place. You plug in the cartridge, and it immediately becomes a part of the computer. The computer has immediate access to the programs and data stored on the cartridge.

RAM memory, although not as intrinsically important to the computer as ROM, serves important functions in the computer. It is the area of memory where user programs are typed in and run. RAM is also used by all the commercial software that comes on disk or cassette. The routines that are located in ROM often have to rely on pointers in RAM to function correctly. Without RAM memory, the computer might not have a screen display, and it would have no such thing as a keyboard buffer to hold extra keypresses. Graphics would not be available either.

Empty Boxes

All memory in the computer can be described as a series of boxes that can hold something. Let's say that you have 1024 different boxes in which to put things. You could choose to place objects in these boxes sequentially from box 0 on up to box 1023, or you could just decide to place objects into boxes in any haphazard way that you yourself could understand. RAM memory is just like a series of empty boxes that allow you to place numbers into them. The only restriction that these boxes impose on you is that you must never place a number over 256 into any one box. If you have a section of memory that has 1024 spaces, you can claim to have 1K of RAM memory. The difference between RAM and ROM when compared to boxes is that ROM memory is like a series of boxes that already have objects in them. Even more important, the boxes can't be emptied or altered by the user. The user can only look into the box to see what's in it. ROM could thus be compared to glass boxes. You can see in but can't remove anything without breaking something.

Any programs that run in RAM memory can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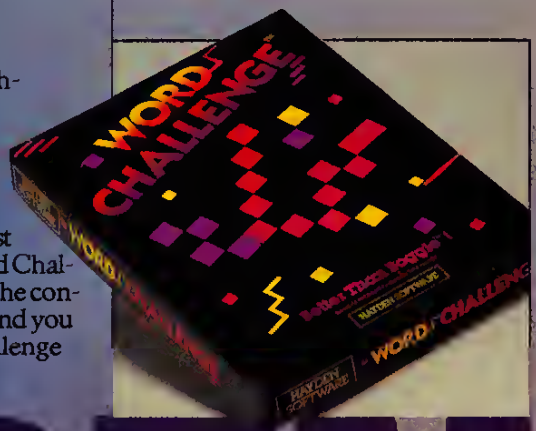

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be modified. For example, if you wrote a program in BASIC and then decided that you wanted to modify something in it, you could easily do so. One peculiarity of BASIC programs is that the RAM in which they are located must be continuous. If there were a gap of any sort, like a missing box, the program would not work properly.

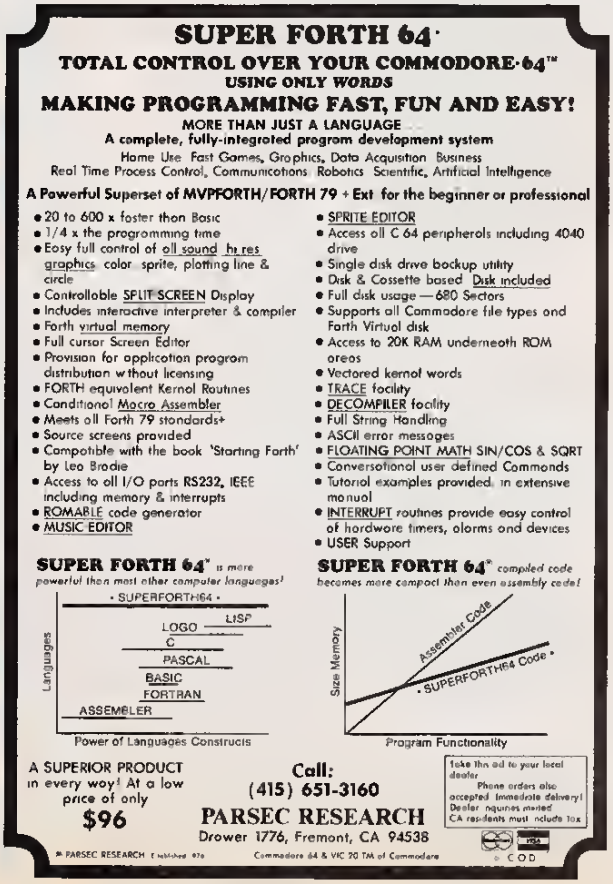
Screen RAM

Perhaps one of the most interesting sections of RAM memory is the screen. It is one of the few RAM locations that are shared by both the central processing unit and the video chip in all computers. What this means is that there is a section of RAM—let's say a 1024 box section—that both the computer's main processing chip and the chip that produces the colorful TV image can look at. The reason it is shared is that you must be able to change the screen either by POKEing values into the screen RAM or by PRINTing values onto it. For you to be able to do this, the central processing unit must have access to it. The video chip needs to have access to the RAM because it needs to know what to display on the TV set. The video chip essentially scans screen RAM and evaluates what is stored there. Once it knows what is in the screen memory, it can reproduce an image of it on your TV.

One useful feature that many home computers come equipped with is that more RAM and ROM can usually be added by just plugging a cartridge into the side or back of the computer. In some computers you have to plug the RAM into the inside expansion areas, but this is usually an easy procedure. The reason expandability is such a desirable feature is that it enables the user to program or use larger programs with more functions and commands and that it facilitates the use of alternate computer languages or BASIC enhancements.

Memory Limitations

There is one limitation to the use of both RAM and ROM. Each microprocessor, the brain chip of each computer, can access only a predetermined amount of memory at any one time. For example, the popular 6502 processor found in the Apple, Atari, and Commodore computers can directly access only 64K of memory. The 8088 microprocessor found in the IBM PC and PCjr can access a little over one million bytes. There are other limitations that manufacturers either impose on their machines or are forced to adhere to. For example, Microsoft BASIC will only accept a program up to 64K long. An example of a self-imposed limitation is that IBM restricted the memory limits of the PCjr to 128K.



The Educational Software Explosion

Kathy Yakal, Editorial Assistant

Even if you didn't buy your home computer as an educational tool, you've probably learned a lot from your interaction with it. Games, home productivity packages, and other computer programs can teach, but recently there's been a proliferation of dedicated educational software. Software developers and publishers are vying for top positions in educational software, potentially a billion-dollar business.

Experts have said that it was pretty easy to predict who the first 6 percent of computer owners would be, says Marilyn Rosenblum, vice president for product development at CBS Software. They're the same people who have expensive hi-fi systems and Sony Walkmans, people who like new technology.

"The important issue for us and for the future of this industry is who the next 6 percent will be," she says. "The thing that's going to determine that is how truly useful we can make computers."

Software publishing firms have been scrambling over the last few years to figure out how they can influence the next 6 percent to buy. The bets right now are on education. "There's been a tremendous proliferation of manufacturers into the educational software market," says Jordan Levy, vice president of marketing at Software Distribution Services.

Levy and many others in the industry who attended last summer's Consumer Electronics Show are overwhelmed by the number of publishers who have either entered the market or added educational software to their already existing line. Future Computing predicts that consumers and schools will purchase 6,787,000 units of educational software this year.

Bringing School Home

"I think you can trace the recent popularity of educational software to penetration of the home computer," says Richard Khaleel, president of Scholastic, Inc.'s Software Group. Game software was popular initially, he says, due to the popularity of the VCS. "And with the penetration of the personal computer into the business market, we saw the explosion of business software."

Further, home computer sales took off partly because children were using them in schools. "The use of computers in schools is probably one of the main reasons for the popularity of home computers," says Khaleel. Market analysts at the Minnesota Educational Computing Consortium (MECC) agree. And as more school districts make computer literacy an important part of the daily curriculum, children are exposed in ever-increasing numbers.

Not Just A Shooting Star

In the rush to find uses for this newly installed base of home computers, a lot of potential applications and inappropriate game ideas have come and gone. With them have gone a lot of software companies. But the concept of education is no fad. "Everyone latched onto education because education doesn't change that much," says Marilyn Rosenblum. "The need to teach children to read and write well will always exist."

Marilyn Rosenblum, vice president for product development at CBS Software.

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Having worked in educational publishing for a number of years before coming to CBS, Rosenblum's perspective of this "explosion" is different. In educational book publishing, it wasn't so much an explosion as an ongoing event. Educational publishers began to add microcomputer software to their existing lines of books and audiovisual materials.

"What we're seeing here is that a lot of the stuff that's been used in the schools is perfectly appropriate for the home," she says. "A lot of the explosion is just recognizing a new market."

Pulling Away From The Pack

Jordan Levy thinks that many software companies sang a swan song at last summer's Consumer Electronics Show. "There will be a lot of people who won't be at the next CES," he says. "A lot of people are going to fall by the wayside, mostly entertainment."

The same thing is bound to happen with educational software over the next few years, say software publishers. But in 1989, consumers will buy about five times as much educational software as they're buying this year, says Future Computing. They predict that 35,072,000 units will be sold in that year.

Whose name is going to be on those packages? Those companies that have experience working with children, says Scholastic's Richard Khaleel. "People who have experience knowing how people learn have the best chance of creating software that is not really state of the art, but state of the *mind*," he says. "No new software publisher that does not have a consumer franchise in another market has been able to spend the kind of money yet to be able to establish a basis for consumer trust."

"It's very important for people who know children, who have traditionally been selling educational materials to children, to get into the business," says Weekly Reader Software Manager Fritz Luecke. "You're going to find fewer unknowns entering the market," he says.

Though parents may feel comforted by familiar names, market analysts at MECC predict that the competitive situation in the educational software market will eliminate those without educational strength and technical skill, as well as adequate marketing ability. "The next 18 months will hold some very hard lessons for those publishers who think the educational buyer is an easy sell," says MECC's Ron Barnes.

No Fun

In all of the brouhaha over which educational software publishers will emerge as leaders, there's a basic problem that everyone's trying to solve: Who deems a program educational? How do you decide when the educational benefits balance the enjoyment?

The argument seems to focus on just how much emphasis there should be on the entertainment aspects of an educational program, if any. There aren't any real rules yet, though educators try to quantify and set standards, and software designers and publishers try to develop formats that they hope will please parents, teachers, and students.

Those formats vary tremendously. "My belief is that educational software should manifest itself in some kind of discernible change in behavior, like grades," says Thomas Garsh, president of American Educational Computer, Inc. "You don't get through high school by being a good games player or having superior cognitive skills. You get through high school by having good grades. And you do not get accepted into college with superior kinds of thinking skills. You get into college by passing the SAT and having good high school grades.

Thomas Garsh, president of American Educational Computer, Inc.

"So what we've done is almost totally related our software to curriculum, by grade and subject," he says. "We've given up a few whistles and bangs, which may initially be a disadvantage because it doesn't look as flashy, but the subject is there. I'm not defending that. I'm just saying that is reality. That's our position. In this rush to the market, I don't see many companies taking that position."

Pupils Of *Pac-Man*?

Software developer Tom Snyder says it's too early to judge, that it's dangerous to impose restrictions or define too concretely right now. "Even *Pac-Man* would be educational if you could freeze the action," he says.

"If you freeze *Pac-Man* or any other game, a couple of things happen," he says. "You get to use your head instead of just knee-jerk reactions. You start verbalizing to yourself what the alternatives are and formalizing them a bit instead of having them remain in sort of an intuitive, physical reaction.

"Beyond that, it really opens the experience up to more

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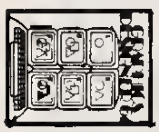

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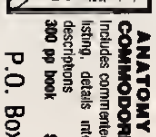

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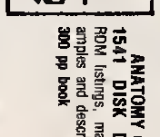

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Software developer Tom Snyder.

than one person. If you slow it down, everyone gathers around and you get five people talking to each other about what a decent strategy might be, and introducing the whole social element into it. That kind of interaction multiplies the learning instantly."

Keeping The Scales Steady

Somewhere between those two opposing viewpoints lie hundreds of software styles, with varying degrees of entertainment and learning. MECC Deputy Executive Director Ron Barnes contends that the learning objective of any piece of software should come first, with the game aspects then designed to increase the child's motivation to learn. Often, he says, educational software is developed the other way around.

DLM Teaching Resources publishes software which is designed to supplement curriculum as first priority. But, they say, what makes their software sell to both schools and homes is that it does not ignore the element of fun. "I think that what software producers are looking for is a correct combination of ingredients to combine into their instructional courses, to keep the interest and focus," says Jim Hafer, product evaluation supervisor for MicroD.

"There seems to be a bit of a gray line there," he says. "Some have a theory that seems to be working, and that is to make education fun. But there's only so much that can be learned from a simple game as opposed to an in-depth program."

Richard Khaleel believes that we will see more segmentation between software that makes learning fun and software that is just drill and practice. "It all depends on the age," he says. "In grade school, homework is fun. It's only when things outside of school get more important that schoolwork competes with other interests. There's always room for both."

Pinning Down The Beast

In the meantime, educators and parents puzzle over how to decide. Not just on what kind of software or computer, but something more basic: whether or not the microcomputer can be used effectively as a teaching tool.

And they can be fooled, says Tom Snyder. "There is an erroneous promise, an implication that you're going to be able to do quantifiable things with it, testing how the education is," he says. "Therefore, it's excited educators and educational consultants who say finally, we can start pinning down this educational beast in general." ©

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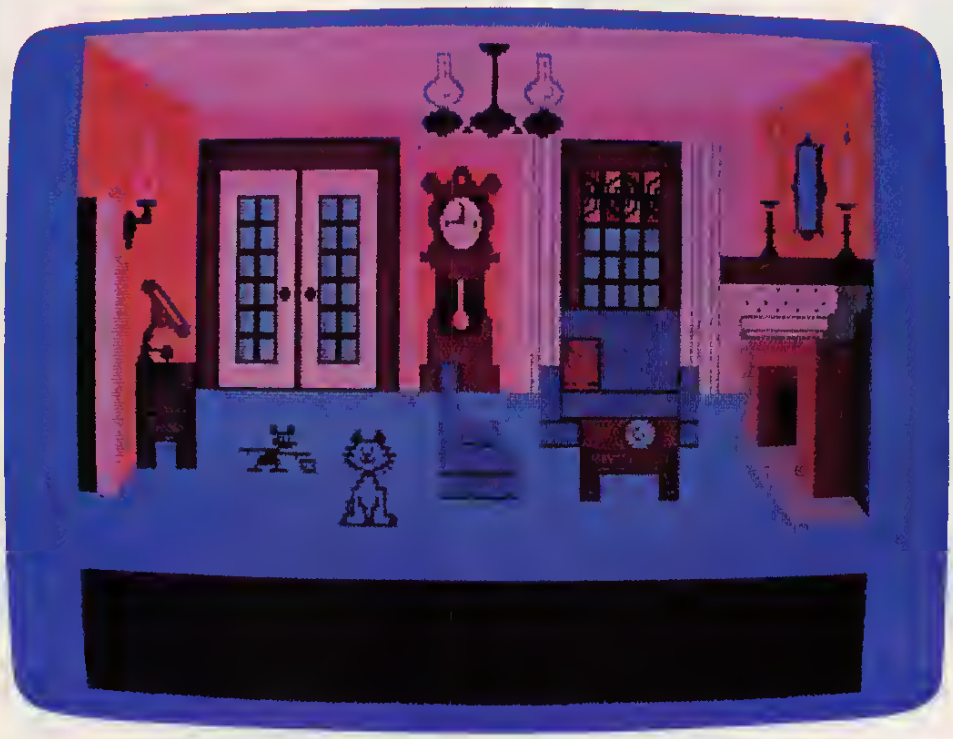

The House That Jill Built *lets youngsters design, build, and animate a variety of houses. Developed by Joyce Hakansson Associates for CBS Software.*

Selby Bateman, Features Editor

Construction sets, interactivity, networking—these are some of the trends in the quickly evolving educational software market. A swarm of new companies have entered the competition, and a variety of different educational approaches are being tried.

Few subjects will generate arguments faster in the microcomputer industry than what makes good educational software.

Interest in computer-based learning programs has never been greater, nor the debate over future directions more vocal. Parents and teachers are requesting more and better packages. Computer companies are courting software firms that specialize in educational products.

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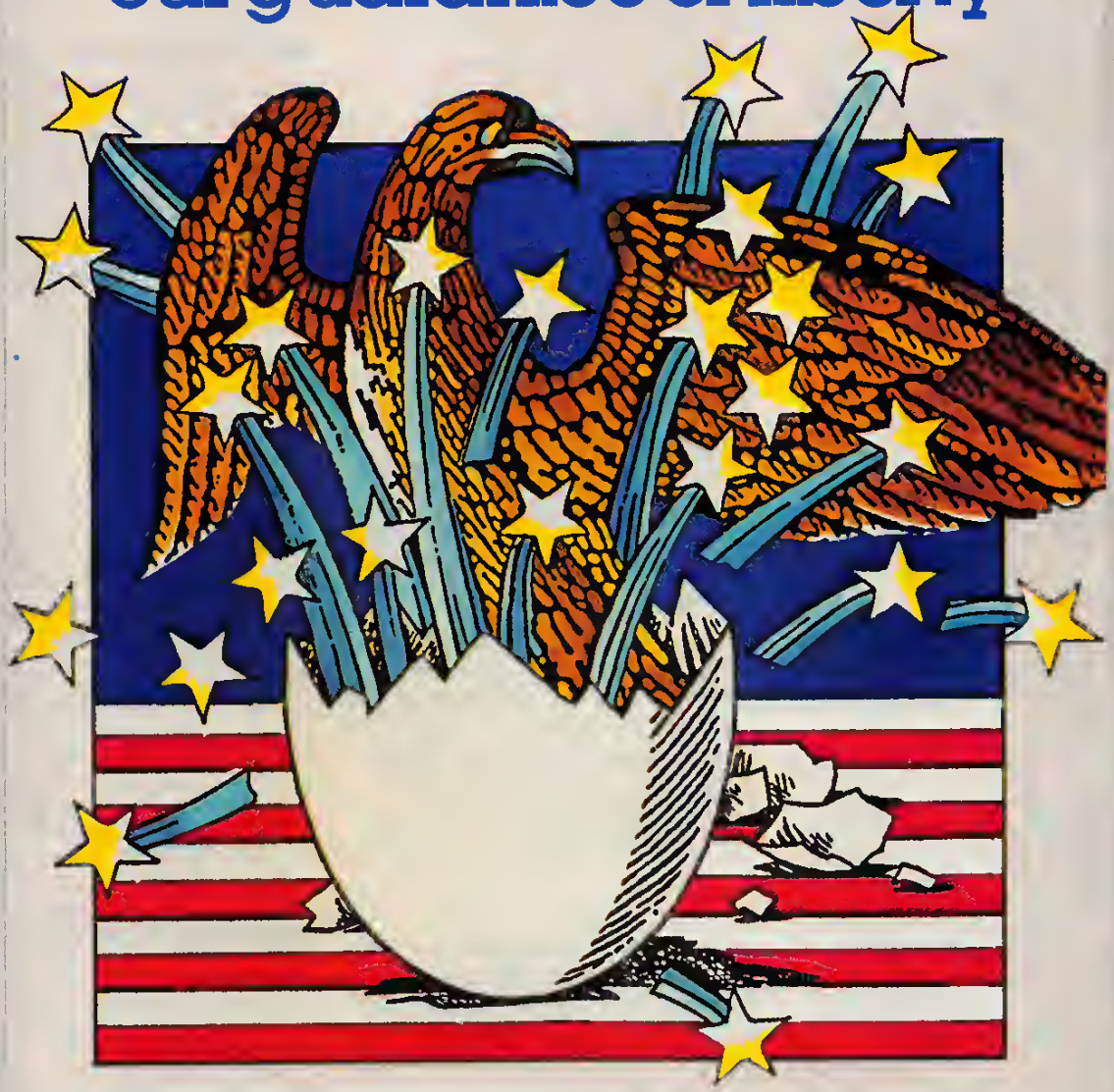

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And greater numbers of educators are getting involved in the production and distribution of these programs.

Increased competition in this growing field is creating several important trends that will directly affect both the quality and the kind of future computer learning programs.

Challenging The Technology

Even staunch supporters admit that educational computer programs generally have a long way to go to reach their potential, but the software is evolving rapidly.

There's now "some clarity about what educational software is," says Marilyn Rosenblum, vice president of product development for CBS Software, a company that produces several lines of educational programs with such developers as Joyce Hakansson Associates and the CTW Software Group from Children's Television Workshop.

"I also think the technology is being challenged much more than it was a year ago. Things that would have been acceptable then are no longer acceptable," she says.

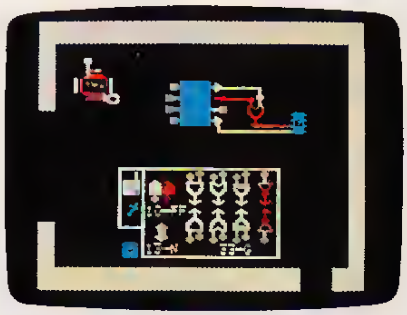
"We're getting away from a lot of drill and practice," adds Marge Kosel, director of microcomputer courseware for Sunburst Communications, a company that produces educational software. "Designwise, drill and practice is the easiest [to produce]. Now, there are a lot more simulations and problem-solving. The technical quality of software has really improved."

Design Your Own Robots

Greater emphasis is being placed on the amount of interaction that occurs between the student and the computer in several of the newer educational packages. And a higher level of sophistication has been built into other programs, as some software developers reach for an older, teen-oriented educational market.

Take, for example, The Learning Company's new *Robot Odyssey I* (Apple II family, $49.95). Inspired by the company's earlier, *Rocky's Boots*, the new package is both a game and an educational tool. It's one of a growing number of products called *construction sets*, or *builders*—a programming style made popular by Bill Budge's *Pinball Construction Set.*

Programs written in this style are highly interactive and allow the player to control



In Robot Odyssey I, *players must build robots to escape from Robotropolis, a futuristic underground city inhabited by robots. Marketed by The Learning Company,* Robot Odyssey I *is the first program in their new DigiWorld series, which is aimed at the teenage market.*

many aspects of the game environment. In *Robot Odyssey I*, for instance, the player actually designs robots and builds computer chips, which are later used to help the player escape from a futuristic robot-run city, Robotropolis. The program features built-in tutorials to teach the basics of digital logic and an Innovation Lab in which players design and test chips and robots.

Atari's Futuremakers And Milestone

New programs from Atari, Inc., also reflect the trend toward greater sophistication. The company's Milestone Series from Atari Learning Systems and its Futuremakers simulation programs are quite interactive and feature a hands-on approach to learning. The AtariLab science packages, part of the Milestone Series, let youngsters simulate more than 100 different experiments using the computer and a laboratory kit.

Socrates On A Chip

The freedom to move almost anywhere within an educational program is an important aspect of the Arrakis Advantage, a family of educational software marketed by Prentice-Hall for Apple, Atari, Commodore, and IBM PC and PCjr computers.

Directed at students in grades 7 through 12, the Arrakis Advantage series is based on the Socrates Learning Environment—a dialectical teaching technique borrowed from the Greek philosopher, notes Charles de Martigny, managing director of Arrakis Systems.

"Where other programs operate in only one direction, Socrates [the system] can move in any direction the user wishes," he says. "Students can interrupt, ask questions, test themselves, review and explore other subjects and, in effect, talk directly to Socrates as naturally as they would converse with a teacher."

Learning Is Parallel, Not Serial

Students need that kind of flexibility since learning is not strictly linear, with one event following another in a predictable chain. Instead, information arrives in a *parallel* fashion, with information coming from a variety of complementary sources, points out Emiliano De Laurentiis, director of advanced research and development for Arrakis.

"People should start looking for software that's more intelligent; software that allows

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you to interact on a normal level, to type in a sentence, to ask questions," he says. "The technology exists now. There's no reason why it shouldn't be implemented."

The Arrakis Advantage series, available this fall, will initially include home programs that complement school curricula in algebra, geometry, biology, chemistry, physics, and statistics.

The Hakansson Touch

Another proponent of the construction set approach is Joyce Hakansson, whose independent software development firm has already produced 19 "playful educational" packages for CBS Software, Simon & Schuster, Spinnaker Software, and Milton Bradley.

"We like to build exploratory worlds for children to investigate—worlds full of sparkling graphics and music and a good measure of giggles," she says. "I want every aspect of a program, even the most subtle, to serve an educational purpose. If a child builds words, then building words should be a powerful tool to make something happen so that the reward is inherent in the activity. We feel a program should validate and support a child's natural intuition and enthusiasm for discovery."

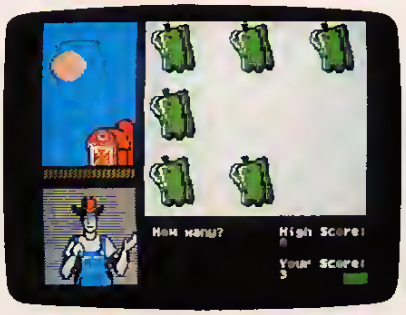
Among the newer programs developed by Joyce Hakansson Associates is *The House That Jill Built* (CBS Software), available now on disk for the Commodore 64 and this fall for the Apple II family.

Build It Your Way

Created for children five years of age and older, the program lets the player design and build a house from the ground up. Youngsters furnish, decorate, and animate the environments simply and easily, but the program also can be used by older children and even adults in more complex ways.

Working from electronic blueprints, you choose one of a variety of four-story houses to build. Doors, windows, and stairways must be placed throughout the house. Exterior styles must be selected (Victorian, modern, or colonial). And once the outside of the house is complete, you then design, decorate, and furnish the interior. Tips on design and notes on architecture are included in the manual.

As the installed base of computers has increased, some software producers who previously concentrated their attentions on a school-based market are coming into the home with programs to supplement their curricular packages.



Youngsters count as many crops as they can before the sun sets in DLM's Number Farm.

It's "Arcademic"

DLM Teaching Resources of Allen, Texas, currently offers hundreds of educational materials for schools. DLM has made the transition into the home software market as well with its Arcademic Skill Builders series in math, language arts, and other areas.

Educational software companies with strength both in the school and in the home will have the best chance of survival, says DLM's Karen McGraw, project editor for microcomputer software and a former teacher. DLM emphasizes content in its packages, she adds, but with a presentation that is also fun for the user and with programs that fully use the capabilities of the computer.

"But we don't want a product just because it is an innovative use of technology, if it's not married to educational validity. We don't build software and then make it fit the child."

Sunup, Sundown

In one of DLM's preschool educational games, for example, a timer is included to let the child know how much time is left in the program. Rather than using a clock, which might have no relevance to a four-year-old who can't yet tell time, the program employs a day-to-night cycle to accomplish the same thing.

At the start of the game, the sun comes up. As the game progresses, the sun crosses the sky and then starts to come down as the game draws to a close. When the sun sets and night comes onto the screen, the game is over.

"We use real-world things that are important to a child, that a child can understand," says McGraw. "Unless you really know about education, unless you really understand the mind of a child, you would never think of it." Drawing on its experiences as a curriculum-based, educational-software producer, American Educational Computer (AEC) is also among those school-oriented software companies which have entered the home market.

"Tested And Tried"

An educational program in the home can be much more effective if it's first been shown to be successful in the schools, argues AEC president, Thomas B. Garsh. "It's been tested and tried and is based on sound educational pedagogy," he says.

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"We know that if a parent buys it for a fifth-grade student and he or she gets better grades, then the parent comes back, says it worked, and buys it for the sixth-grade child."

The movement of software from the school to the home is accelerating. Control Data Corporation, developers of the widely used Plato system of educational software, now has more than 12,000 hours of courses that include everything from instruction in basic skills and computer literacy to educational games and advanced calculus. And the company is in the process of converting many of its packages for use on personal computers like the Apple II family, Atari, IBM, and Texas Instruments.

The More The Merrier

A related trend over the last year or so is the entry of large corporations, especially established educational publishers, into the home software field. Companies like Random House, Prentice-Hall (Arrakis Systems), SFN Companies (Mindscape), Xerox (Weekly Reader Software), Scholastic, Simon & Schuster, and Fisher-Price are bringing their talent, marketing muscle, and reputations into the computer learning field.

"And that's very good," says Fritz Luecke, manager of computer software for Weekly Reader Software. "Most of them bring something to the business that other traditional software companies might not bring, and that is a different kind of marketing expertise.

"They also bring, in many cases, a new way of packaging, a new way of adding things to a program to make it a total program, which is what we feel we have done with our products," he adds.

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Choosing The Best Educational Software

Selby Bateman, Features Editor
Sharon Darling, Research Assistant

Of the thousands of educational software programs available, which ones are worth your time and money? Here's a short lesson from the experts.

"One recommendation I always make to parents—one that not enough people are making—is that you should really begin to look for educational software for your three- or four-year old child," says William Bowman, chairman of Spinnaker Software.

"That's the time to begin thinking about buying a home computer and getting educational software. It's going to be easier for you to find things that are generally applicable to the learning skill areas of young children than it will be to find the more specific software for older kids," he adds.

Getting Involved

Spinnaker's educational software lines include the new Fisher-Price Learning Software for children from three to twelve years of age, as well as such best-selling programs as *Kindercomp, Alphabet Zoo, In Search of the Most Amazing Thing,* and *Kids On Keys.*

"The next real criterion is that the software's got to be fun," says Bowman. "If it's not fun to use, kids won't use it no matter what their ages are—and that's where an awful lot of educational software falls down. The next thing for a parent to do is to consider how much he or she is going to be involved with the child. A little involvement is always required. But some software, like Spinnaker's, really expects the parent to be more involved," he adds. "The software is a little bit deeper, it's a little more advanced in terms of what you can do with it."

Trying It On For Size

Getting educators and software developers to agree on a set of specific guidelines would be almost impossible, given the many conflicting views which abound in the computer-based learning field. But there are a few fundamental pieces of advice for anyone buying educational software. The following tips from educators, software houses, and leading independent program developers may be of help as you wade through the flood of educational software packages:

• **Shop at a software store that allows you to run some programs prior to purchase, or that lets you buy packages on approval.** Such stores may not be easy to find right now, but retailers are discovering that an increasing number of customers are demanding more than just the promises on the outside of a package to buy an educational software product.

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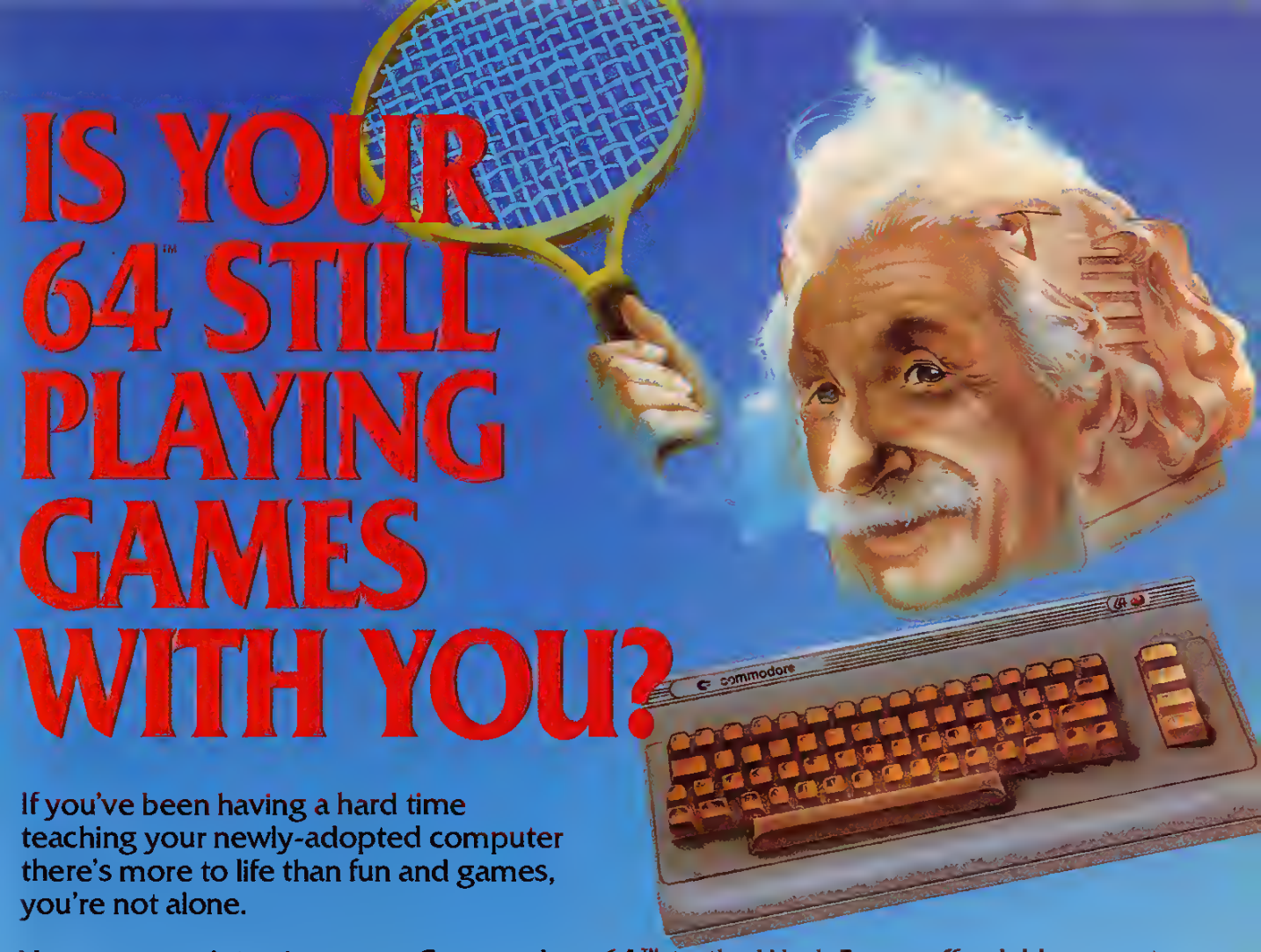

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which they are familiar—books, stickers, posters—in addition to the software package makes it easier for the youngsters to relate to the product, Luecke says.

While numerous educational software companies are expanding their operations from school orientation to include the home market, the growth is very much a two-way street. Other companies, which have previously sold software strictly to the home, are approaching schools with their products. And the success which some microcomputer hardware manufacturers—especially Apple Computer—have had in donating products to school systems, is now spurring more software companies to try similar tactics.

Using the slogan, "Be a hero, software your school," Scarborough Systems of Tarrytown, New York, is embarking on a major school-donation project this fall.

Those who purchase Scarborough educational programs between September 15 and December 15 will find a coupon in each package enabling them to donate a piece of educational software to the school and teacher of their choice. The donated program does not have to be the same one purchased.

The purchaser sends the coupon and $3.50 for postage and handling to Scarborough. The company will then donate the software to the school. A gift card telling the name of the donor and the name of the dealer where the software was purchased will be included in the donation.

"We think it's a unique program, and it may provide up to $4 million in the value of computer software—that's 125,000 programs," says Sanford K. Bain, vice president of marketing for Scarborough Systems. The company has computer software for four machines—the Apple II family, Commodore 64, IBM PC/XT/jr, and the Atari

"Buying blind" is the way Dr. Sam Barkliss, chief executive officer of Computerose, Inc., an educational software firm, describes the predicament most parents and some teachers find themselves in when purchasing educational packages. They should be offered the opportunity to test the educational value of software before a purchase.

But What Does It Really Do?

• **Determine what age and learning levels the software is designed for.** Once that is established, find out exactly what the program intends to teach, says Leigh Mosley, an educational consultant at Peachtree Software. "A parent should ask, 'Is my son or daughter going to learn from it?'"

Some companies are better than others at telling you who the target audience is, what level of learning is required, and what the goals of the packages are. Always keep in mind the software user—the child's age, learning level, interests, and dislikes.

• **Be aware that the nature of "educational content" is often difficult to assess—and usually the subject of much debate among educators and software houses.** Many educators and software producers believe that specific learning objectives are crucial in producing good computer-based educational products. Others stress the validity of programs which invite youngsters to explore and "play" in a less structured learning environment.

The General And The Specific

For example, software that stimulates a student's creativity might be more useful than a program that deals with a specific learning problem in school, notes Kent Kehrberg, director of software for the Minnesota Educational Computing Consortium.

"It may be difficult for a parent to match up a very specific program with a problem a child is having in, say, algebra," he says. "In a case like that, it's very difficult for someone besides the teacher to pinpoint [the problem]."

• **Read published reviews and other articles about software packages and the goals of various software companies.** The more knowledgeable you are about manufacturers and their products, the easier your task when picking out new software.

Tutorials, Simulations, And Drill-And-Practice

For example, when shopping for software, parents should know the three basic types of educational programs—tutorials, drill-and-practice, and simulations, notes Sherwin A. Steffin, vice president for research and development at Eduware Services, Inc.

"Tutorials help you attain a new skill or understanding," he says. "They generally ask the question, 'How to?' With drill-and-practice, you already know how, but want to know better, so you need repetitive exercises." Simulations can offer examples of the way things work in just about any field.

• **Consider how much replay value, or depth, a product has.** Will the child use the package a few times and tire of it, or is there enough variety and challenge to offer a stimulating environment?

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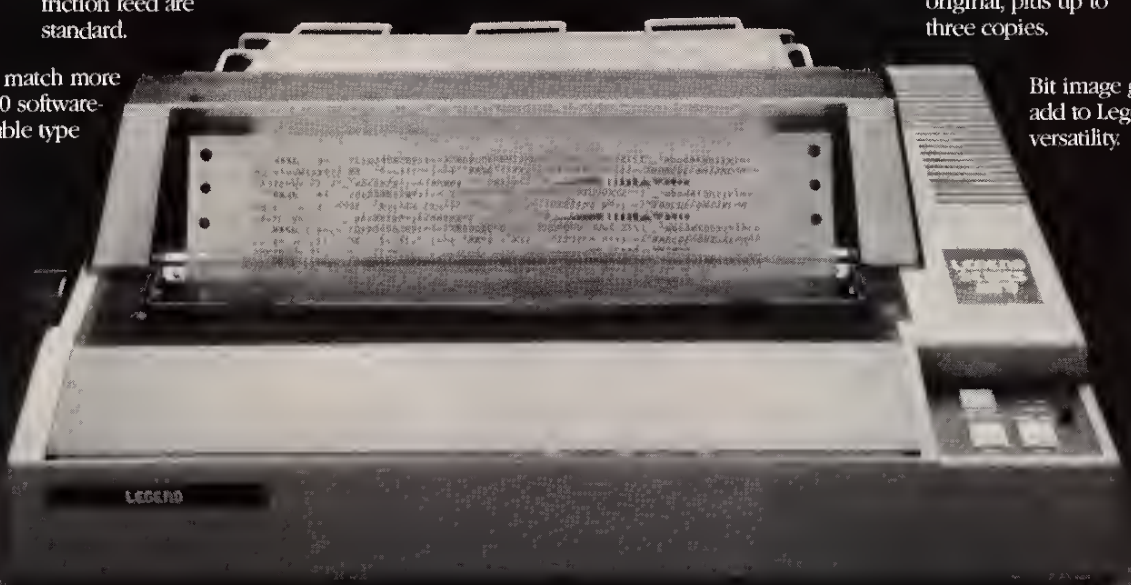

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"Obviously, we're doing it because we think it reflects a favorable image for the company," Bain says. "We strongly believe the validity for these programs has to come from the schools. And our donation program allows schools to sample software without great expense on their part."

To Network Or Not To Network?

One school-based trend that disturbs DLM President Andrew W. Bingham is the tendency for schools to network their computers, which Bingham says can work against innovative use of the computers.

"It almost scares me, because I think the evolution may ultimately lead us to miss the revolutionary potential of software," he says. "When there are just two or three computers in a school, teachers will use them flexibly and individually.

"When the school gets more computers, they bring them all together into one room, because it's easier to control, easier to administer. Then they want a networking system," says Bingham. "What you get is students being marched to the computer for their 20 minutes of instruction and marched back to their seats."

Bingham urges parents and teachers to explore innovative uses of the computer rather than trying to emphasize convenience of management.

No matter what the area of computer-based educational programs, software companies and educators all agree that the field is still in its infancy in many ways. And expectations for the future are bright. "I think we're going to see an explosion in the next couple of years," says Sam Barkliss, chairman of Computerose, Inc., an educational software company. "I think we're going to see some astonishing things."

As William Bowman puts it, "Does the software provide multiple paths to creativity, and does it accept multiple paces from different children?"

The Price Tag For Learning

• **Price and future availability of software from the same company can be important factors.** Depending on the needs of the student and the goals of a company's software line, you may wish to purchase an entire series of complementary programs over time. How much this will cost you and its effects on the student's learning goals then become very important.

"A lot of people out there are getting too great a price for what they're selling, and for what the market will support," says George Esbensen, national sales coordinator for MicroEd, a Minnesota-based company which produces educational software. "A lot of what's being passed off as educational software is not."

• **Take your child to the store when selecting software.** This can be especially helpful—and save you later disappointments—if the child can actually see the program working in the store. If that's not possible, at least you can get a better idea of some of the likes and dislikes of the youngster for whom you're purchasing the program.

Sophistication, Power, And Interaction

• **How flexible is the software program? Are there built-in options which allow a variety of challenges and motivational changes as the user works with the program?** As computers become more powerful and software becomes more sophisticated, the level of interactivity between user and program is increasing dramatically. The best educational software takes advantage of that power and sophistication.

• **Is the software both easy to use and error-free?** Educational programs which freeze up or frustrate a user can immediately discourage users, especially younger children. Be aware of both potential problems as you evaluate software you see or that you've purchased.

Fritz Luecke, manager of computer software for Weekly Reader Software, suggests that you determine how easy and helpful the program guide booklet is that comes with the package. Many parents, teachers, and students want to be able to insert a program into the computer and use it without having to use a guide, particularly if that guide is confusing or incomplete.

NEA Teacher Certified

Finally, you might want to look at the NEA catalog of educational software. With the proliferation of educational software packages, the job of separating the good from the mediocre gets tougher every day. For more than a year now, the National Education Association (NEA) has been trying to give some guidance in this area. Approximately 50 NEA reviewers have been testing educational programs submitted by software authors and publishers. Those which meet the NEA's stiff requirements are given an "NEA Teacher Certified" stamp of approval, and are included in a catalog of approved software. ©

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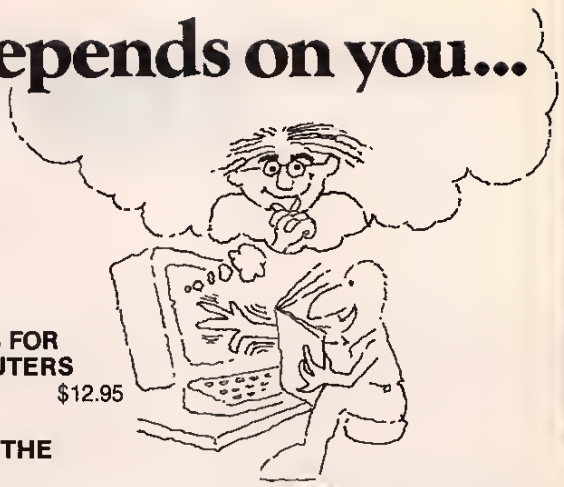

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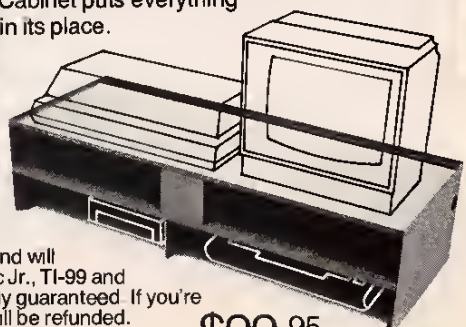

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The Tester

Joseph Kattan

Multiple-choice tests have been standard for years. Now anyone who wants to create a multiple-choice test on his home computer can easily do so. Tests can be devised to teach youngsters anything from history to sports trivia. Just fill in the DATA statements with the questions and answers and the program will do the rest. Versions that work on the Commodore 64, VIC-20, PETs, Apples, Radio Shack Color Computer, Coleco Adam, IBMs and TI-99/4A are included.

One of the most frequently cited reasons for purchasing a personal computer is its great potential as an educational tool. The home computer is widely used to teach children to spell or perform simple arithmetic calculations and to drill adults on anything from foreign languages to organic chemistry. A well-designed instructional program can produce spectacular results in improving a student's command of a subject. A poorly designed program, on the other hand, will frustrate, rather than teach.

Computers, for better or worse, cannot yet think. If the programmer tells the computer that Washington is the capital of the United States, the program will be less than kind to the hapless user who responds that Washington, D.C., is the capital. If the programmer tells the computer that *avoir* means "to have," pity the French student who answers "to possess." These are, of course, soluble problems, but they illustrate one weakness in computerized instruction. No matter how well designed the program, there will always exist a correct answer to some question that the program will not recognize. You can instruct a program to accept Washington, Washington, D.C., and Washington, DC, as the answer to the capital question, but how do you cover all of the synonyms of a word like *fantastic* in a foreign language translation program?

No Ambiguity

There is one kind of testing that a computer handles exceptionally well, because it is not required to reason: multiple-choice. It takes little effort to insure that the answers to a multiple-choice test are free of ambiguity, which is why all of the standardized testing in our schools tends to be multiple-choice. These tests, moreover, require less effort on the part of the user than answer-oriented tests, and can be used together with the more rigorous answer-oriented tests to form a very effective instructional package.

Remembering To Answer

Designing an effective program for a multiple-choice test is no easy matter, however. A simple and commonly used algorithm selects a question from DATA statements at random and then reads four or five different answers from the DATA statement, together with a code that identifies the correct answer.

There are several deficiencies to this solution. For one, it consumes tremendous amounts of memory, as it gobbles up bytes both for the correct answer and for the dummy answers that have no use other than to serve as the incorrect choices. In addition, the program user is always presented with the same set of choices, and in the same order, for each question. The user may well get into the habit of remembering that the answer to a question is C without learning the answer itself.

A more elegant solution should present truly random choices for each question. The user should rarely, if ever, encounter the same choices for a given question. The program, moreover, will be more compact because every answer in its DATA statements will be a correct answer to some question. With this method, the program will select a question from a DATA statement at random, will read the answer to that question from the same DATA statement, and then read four more answers at random to present as false choices. This method insures that the same answer is not presented as two separate choices (since random selection could cause that result) and arranges the order of the answers at random. The U.S. capital may be C on one run of the test, but A or B or D on another.

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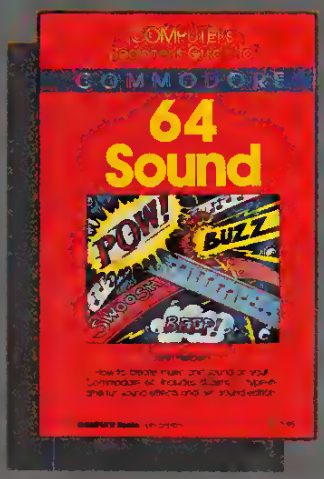

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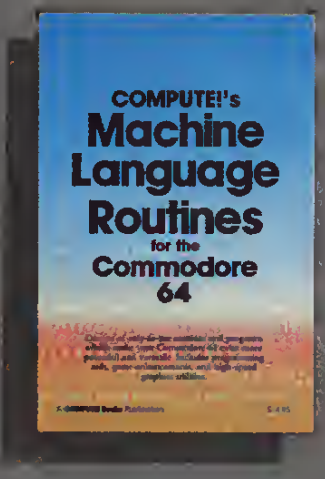

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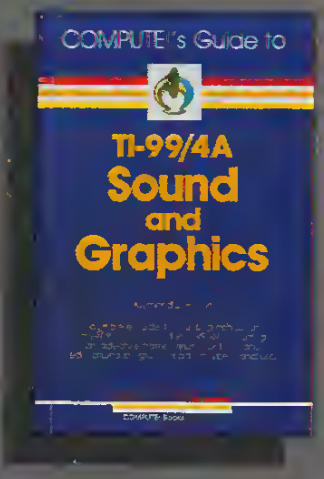

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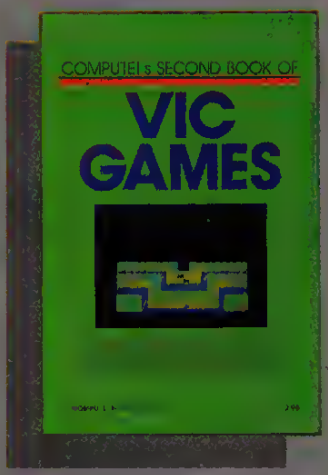

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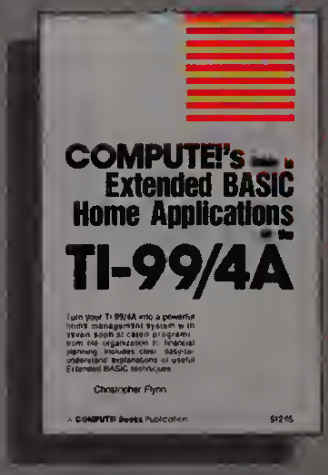

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Segregated Data

Even this method, however, has a potential pitfall, and the solution discussed here resolves it. Let's take a U.S. history test as an example. The answers to such a test may be George Washington, or Philadelphia, or 1776. Obviously, it would be quite absurd to present Philadelphia or 1776 as possible answers to a question calling for the name of the first president. The solution to this problem is to segregate the DATA statements containing the questions and answers into different areas of the program and to select answers to each question only from a valid area. For example, DATA statements between 1000 and 1999 could contain questions concerning names of persons; DATA statements between 2000 and 2999 could contain questions concerning places; and so forth. The program chooses an area at random and then stays in that area to present the incorrect answers. If the answer to the question selected is George Washington, the four incorrect answers will always be names of persons.

This solution has an added advantage. It allows for the inclusion of diverse subjects on a single test, with the testing either confined to a subject chosen by the user or mixed at random by the computer. This program is intended primarily for single-subject tests that require the segregation of answers by types, as in the U.S. history example above.

How It Works

The program relies on two arrays—Q, which stores the number of questions in each category, and T, which selects the answers at random. The variable N is used to store the group of questions and answers to be called. The question and answer are selected by the computer at line 300. Since answer groups are stored in DATA statements beginning with 1001, 2001, and so forth, the program adds that number to a random number from 1 to the number of questions for the appropriate group, as indicated in the Q array. For example, if the question and answer are to come from group 1, for which questions and answers are stored in lines 1001 through 1011, the program looks to the variable Q(1) to ascertain the range of random numbers to generate.

Once a question and answer have been read, the program uses the same random number formula to look up the incorrect answers. It stores the random numbers (data line numbers) in a T array (line 330) and makes sure that none of the numbers in that array is equal to the line number of the correct answer or to the number of another element in the array (line 335). At line 340, the program chooses where to place the correct answer, which can be any choice from one to five, and then proceeds to place all of the choices on the monitor or television screen. Once an answer is entered, the program indicates whether or not it was correct. In the case of a correct answer, the program waits for two seconds (lines 400 and 410) and then constructs a new screen. If the answer entered is incorrect, the program waits for the RETURN key to be pressed before moving on to the next screen.

Screening Keys

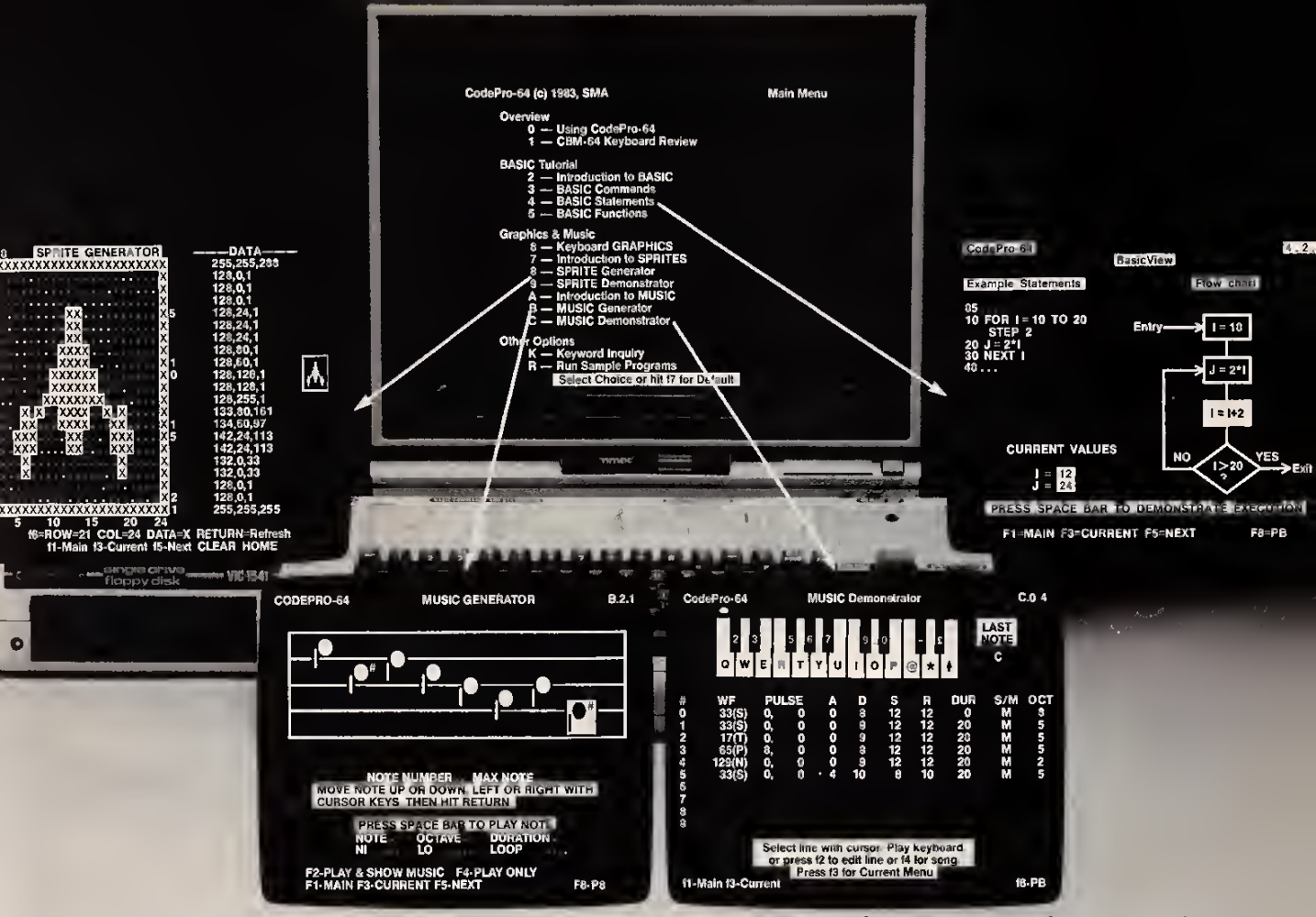
One other matter is the little subroutine beginning at line 800. The entire subroutine could be replaced with a single INPUT statement. The advantage of the subroutine is that it screens out unwanted keys (in this case, anything but a number) and maintains the integrity of the screen display. In addition, the subroutine does not attach a question mark to a prompt, allowing you to insert it where it is appropriate and omit it where it is not. Study the DATA statements beginning at line 1001 and you can see the flexibility afforded by the subroutine.

This program is obviously meant to be modified. When modifying it for your own use, pay special attention to the Q array. The array should be DIMensioned to the number of answer categories in the program. The same number should be placed in the variable SUBJ. The elements of the Q array should be equated to one more than the number of questions in the appropriate category. Finally, the questions and answers should be placed on the same DATA statement, and the DATA statements should be arranged in increments of one beginning with a line number of N*1000+1, N being the number of the group. Make sure that neither the questions nor the answers contain any commas, since the BASIC interpreter will take the commas to indicate the end of a string.

Program 1: The Tester, Atari Version

Refer to the "Automatic Proofreader" article before typing this program in.

```
PN 10 REM THE TESTER
DK 20 REM MULTIPLE-CHOICE TEST MAKER
BL 40 REM THIS PROGRAM WILL GENERATE
OJ 50 REM MULTIPLE-CHOICE TESTS FOR
      ONE
IB 60 REM OR MORE SUBJECTS
CI 100 POKE 710,78:POKE 712,78:POKE
       709,4:POKE 752,1:REM SET SCRE
       EN COLORS, TURN CURSOR OFF
MJ 110 OPEN #1,4,0,"K:"
JF 120 DIM TITLE$(38),QUES$(38),ANS$
       (30),TEMP$(30),NUM$(3),BL$(30
       ),Q(4),T(3)
DJ 130 TITLE$=" ":TITLE$(38)=TITLE$:
       TITLE$(2)=TITLE$:QUES$=TITLE$
       :ANS$=TITLE$(1,30):TEMP$=ANS$
       :BL$=ANS$
```



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```
DL 140 Q(1)=11:Q(2)=11:Q(3)=11:Q(4)=
       11:REM INSERT HERE ONE LESS T
       HAN NUMBER OF QUESTIONS FOR E
       ACH CATEGORY
DJ 200 ? "{CLEAR}{4 SPACES}PLEASE CH
       OOSE ONE SUBJECT:"
MC 205 SUBJ=4:REM SUBJ IS NUMBER OF
       SUBJECTS IN TEST
PK 210 ? :RESTORE 900:FOR I=1 TO SUB
       J:READ TITLE$:? I;") ";TITLE$
       :NEXT I:?
FP 220 GOSUB 800:IF N1<1 OR N1>4 THE
       N POSITION C,R:GOTO 220
DN 230 N=N1:? :? "HOW MANY QUESTIONS
       ? ";
NB 240 GOSUB 800:IF N1<1 THEN POSITI
       ON C,R:GOTO 240
HJ 250 TOTAL=N1:RESTORE 900:FOR I=1
       TO N:READ TITLE$:NEXT I:TITLE
       $(LEN(TITLE$)+1)=" TEST"
KI 300 SCORE=0:FOR COUNT=1 TO TOTAL:
       ? "{CLEAR}":POKE 85,(40-LEN(T
       ITLE$))/2:? TITLE$:?
MG 310 ANS=N*1000+1+INT(RND(0)*Q(N))
       :RESTORE ANS:READ QUES$:? QUE
       S$:? :READ ANS$
AJ 320 FOR I=0 TO 3
NH 330 T(I)=N*1000+1+INT(RND(0)*Q(N)
       ):IF T(I)=ANS THEN 330
PJ 335 FOR J=0 TO 3:IF I<>J AND T(I)
       =T(J) THEN POP :GOTO 330
DM 340 NEXT J:NEXT I:J=1+INT(RND(0)*
       5):A=0:FOR I=1 TO 5:? I;") ";
AK 350 IF I<>J THEN RESTORE T(A):REA
       D QUES$:READ TEMP$:? TEMP$:A=
       A+1:GOTO 370
NO 360 ? ANS$
JL 370 NEXT I:?
GD 380 GOSUB 800:IF N1<1 OR N1>5 THE
       N POSITION C,R:GOTO 380
DE 390 IF N1<>J THEN 430
DH 400 SCORE=SCORE+1:? :POKE 85,18:?
        "GOOD !":POKE 20,0
GF 410 IF PEEK(20)<90 THEN 410
GJ 420 GOTO 460
PK 430 ? :? "SORRY, THE ANSWER IS ";
       :IF LEN(ANS$)>18 THEN ?
II 440 ? ANS$:? :? "{6 SPACES}PRESS
       RETURN TO CONTINUE"
PD 450 POKE 764,255:GET #1,A:IF A<>1
       55 THEN 450
GC 460 NEXT COUNT
EI 500 ? "{CLEAR}":POKE 85,(40-LEN(T
       ITLE$))/2:? TITLE$:?
CM 510 ? "OUT OF ";TOTAL;" QUESTIONS
       , YOU ANSWERED":? SCORE;" COR
       RECTLY. YOUR SCORE IS ";
NN 520 ? INT((SCORE/TOTAL)*100+0.5);
       "%."
HM 530 ? :? "RETURN FOR ANOTHER TEST
       , * TO END"
OH 540 POKE 764,255:GET #1,A:IF A<>1
       55 AND A<>42 THEN 540
AD 550 IF A=155 THEN 200
KM 560 ? "{CLEAR}":END
KG 800 C=PEEK(85):R=PEEK(84)
MG 805 POSITION C,R:? 8L$:TRAP 805:Y
       =1:S=0:NUM$=""
KH 810 POSITION C+Y-1,R:? "{T}";:POK
       E 764,255:GET #1,A:POSITION C
       +Y-1,R:IF A<>126 THEN 825
AP 815 IF Y>1 THEN Y=Y-1:? " ";:NUM$
       =NUM$(1,Y)
GM 820 GOTO 810
AI 825 IF A=155 THEN ? " ":GOTO 840
DD 830 NUM$(Y,Y)=CHR$(A):IF Y=1 THEN
       S=A
DD 835 ? CHR$(A);:Y=Y+1:GOTO 810
MD 840 POKE ADR(NUM$),S:N1=VAL(NUM$)
       :RETURN
EJ 900 DATA HISTORICAL FIGURES,WORLD
       CITIES,NEWSMAKERS,COMPUTERS
KM 1000 REM HISTORICAL FIGURES
MK 1001 DATA THE FIRST PRESIDENT,GEO
       RGE WASHINGTON
BK 1002 DATA FIRST CHIEF JUSTICE,JOH
       N JAY
EL 1003 DATA WHO INVENTED COTTON GIN
       ? ELI WHITNEY
GL 1004 DATA PRESIDENT OF THE CONFED
       ERACY,JEFFERSON DAVIS
FH 1005 DATA WHO DEBATED LINCOLN?,ST
       EPHEN DOUGLAS
FK 1006 DATA FAMOUS ABOLITIONIST,FRE
       DERICK DOUGLASS
DL 1007 DATA BRITISH NAVIGATOR,FRANC
       IS DRAKE
IH 1008 DATA THE THIRD PRESIDENT,THO
       MAS JEFFERSON
```

Microsoft And TI-99/4A Version Notes

Jeff Hamdani, Editorial Programmer

The Microsoft version of "The Tester" (Program 2) runs on the Commodore 64, the VIC-20, all PETs, the Apple II+, IIc, and IIe, the Radio Shack Color Computer, the Coleco Adam, and the IBM PC and PCjr. If you have a VIC without memory expansion, remove all REMs and spaces when typing in the program. With an IBM PC or PCjr, make the following minor changes:

Add line 100:

```
100 RANDOMIZE(0)
```

Change line 220 to:

```
220 PRINT:PRINT "YOUR CHOICE:";
```

Add line 225:

```
225 Z$=INKEY$:RD=RND:N=VAL(Z$):IF
Z$="" OR (N<1 AND N>4) THEN 225 ELSE
PRINT N
```

Last, in Program 2, line 930 contains a statement to clear the screen. Replace this with the appropriate statement for your computer. For instance, on the Apple, line 930 would read:

```
930 HOME:RETURN
```

The TI-99/4A version of The Tester (Program 3) will run in either Console or Extended BASIC.

```
NF 1009 DATA HE PRESIDED OVER THE NE
        W DEAL,FRANKLIN DELANO ROOSE
        VELT
JM 1010 DATA WHO WAS ASSASSINATED IN
         DALLAS?,JOHN F. KENNEDY
PD 1011 DATA RAILROAD MAGNATE,CORNEL
        IUS VANDERBILT
HP 2000 REM WORLD CAPITALS
IM 2001 DATA WHAT IS THE CAPITAL OF
        JAPAN?,TOKYO
IP 2002 DATA WHERE IS TRAFALGAR SQUA
        RE?,LONDON
EC 2003 DATA WHERE IS THE WESTERN WA
        LL?,JERUSALEM
NH 2004 DATA WHERE IS THE COLISEUM?,
        ROME
OH 2005 DATA WHERE IS RED SQUARE?,MO
        SCOW
KC 2006 DATA WHERE IS THE TAJ MAHAL?
        ,AGRA
CF 2007 DATA WHAT IS THE CAPITAL OF
        AFGHANISTAN?,KABUL
AH 2008 DATA THE PARTHENON IS IN THI
        S CITY,ATHENS
HD 2009 DATA CITY LEASED BY ENGLAND
        FROM CHINA,HONG KONG
KH 2010 DATA WHERE IS THE LINCOLN ME
        MORIAL?,WASHINGTON
CF 2011 DATA THIS CITY IS FAMOUS FOR
         ITS CANALS,VENICE
KH 3000 REM NEWSMAKERS
KE 3001 DATA PRESIDENT OF FRANCE,MIT
        TERAND
OD 3002 DATA FORMER SECRETARY OF STA
        TE UNDER REAGAN,HAIG
ID 3003 DATA SOVIET FOREIGN MINISTER
        ,GROMYKO
NA 3004 DATA GERMAN CHANCELLOR,KOHL
EB 3005 DATA SECRETARY OF TREASURY,R
        EGAN
KN 3006 DATA CHAIRMAN OF SOVIET COMM
        UNIST PARTY,CHERNENKO
EB 3007 DATA CANADIAN PRIME MINISTER
        ,TRUDEAU
JA 3008 DATA JAPANESE PRIME MINISTER
        ,NAKASONE
ME 3009 DATA SECRETARY OF STATE,SHUL
        TZ
HL 3010 DATA MAYOR OF NEW YORK,KOCH
FL 3011 DATA BRITISH PRIME MINISTER,
        THATCHER
GK 4000 REM COMPUTERS
ME 4001 DATA THE BRAIN OF THE COMPUT
        ER IS CALLED,CENTRAL PROCESS
        ING UNIT
AN 4002 DATA THE FASTEST WAY TO PROC
        ESS DATA,MACHINE LANGUAGE
CN 4003 DATA A SIMPLE COMPUTER LANGU
        AGE,BASIC
CI 4004 DATA USES REVERSE POLISH NOT
        ATION,FORTH
PI 4005 DATA 8 BITS ON THE 6502,BYTE
PM 4006 DATA A 16-BIT MICROPROCESSOR
        ,68000
GF 4007 DATA TRANSFERS DATA FROM MEM
        ORY TO CPU,BUS
AA 4008 DATA DATA ARE PUSHED AND PUL
        LED HERE,STACK
OO 4009 DATA USED FOR INDEXING,X REG
        ISTER
NG 4010 DATA FASTEST COMPUTATIONS TA
        KE PLACE HERE,PAGE ZERO
OO 4011 DATA A NUMBERING SYSTEM,HEXA
        DECIMAL
```

Program 2: The Tester, Microsoft Version

Refer to the "Automatic Proofreader" article before typing this program in.

```
20 REM *** MULTIPLE CHOICE TEST MAKER ***
                                    :rem 9
110 DIM QA$(44),AN$(44):GOSUB 930:FOR I=1
    TO 44                          :rem 172
120 READ QA$(I),AN$(I):NEXT I:FORJ=1 TO 4
    :Q(J)=10:READ TL$(J):NEXT J    :rem 38
200 GOSUB 930:PRINT "PLEASE CHOOSE ONE SU
    BJECT:"                        :rem 96
210 PRINT:FOR I=1 TO 4:PRINT I;") ";TL$(I
    ):NEXT I                       :rem 226
220 PRINT:PRINT "YOUR CHOICE";:INPUT Z$:N
    =VAL(Z$):IFN<1 OR N>4 THEN 200
                                   :rem 198
230 PRINT:PRINT:PRINT "HOW MANY QUESTIONS
    ";:INPUT Z$:N1=VAL(Z$)         :rem 13
240 IF N1=0 THEN 230               :rem 213
300 TL=N1:SC=0:FOR CT=1 TO TL:GOSUB 930:P
    RINT TL$(N);" TEST"            :rem 212
310 ANS=INT(RND(1)*Q(N))+(N*11)-10:PRINT:
    PRINT QA$(ANS)                 :rem 202
320 FOR I=0 TO 3:GOSUB 800:J=0     :rem 75
330 IF I<>J AND T(I)=T(J) THEN GOSUB 800:
    J=0:GOTO 330                   :rem 96
335 J=J+1:IF J<=3 THEN 330         :rem 76
340 NEXT I:J=1+INT(RND(1)*5):A=0:PRINT:PR
    INT:FOR I=1 TO 5:PRINT I;") ";:rem 86
350 IF I<>J THEN PRINT AN$(T(A)):A=A+1:GO
    TO 370                         :rem 60
360 PRINT AN$(ANS)                 :rem 12
370 NEXT I:PRINT                   :rem 233
380 PRINT:PRINT "ENTER YOUR ANSWER";:INPU
    T Z$:N1=VAL(Z$)                :rem 251
390 IF N1<1 OR N1>5 THEN 380       :rem 116
395 IF N1<>J THEN 430              :rem 57
400 SC=SC+1:PRINT:PRINTTAB(9) "GOOD !":FO
    R I=1 TO 1000:NEXT I:GOTO 460:rem 225
430 PRINT:PRINT "SORRY, THE ANSWER IS:":P
    RINT AN$(ANS)                  :rem 46
440 PRINT:PRINT "<RETURN> TO CONTINUE"
                                   :rem 146
450 INPUT Z$                       :rem 167
460 NEXT CT                        :rem 112
500 GOSUB 930:PRINT TL$(N);" TEST"
                                   :rem 154
510 PRINT:PRINT:PRINT "TOTAL QUESTIONS ";
    TL:PRINT "CORRECT ANSWERS ";SC:rem 48
520 PRINT "YOUR SCORE IS ";INT((SC/TL)*10
    0+.5);"%"                      :rem 233
530 PRINT:PRINT "WANT ANOTHER TEST(Y/N)"
                                   :rem 226
540 Z$="":INPUT Z$:IF Z$<>"Y" AND Z$<>"N"
     THEN 530                      :rem 98
550 IF Z$="Y" THEN 200             :rem 66
560 GOSUB 930:END                  :rem 200
800 T(I)=INT(RND(1)*Q(N))+(N*11)-10:IF T(
    I)=ANS THEN 800                  :rem 0
810 RETURN                         :rem 121
900 REM THIS SUBROUTINE CLEARS THE SCREEN
    . FOR APPLE COMPUTERS USE "HOME"
                                   :rem 195
910 REM FOR IBM PC AND PCJR.,      :rem 44
920 REM AND TRS-80 COLOR COMPUTERS USE "C
    LS" STATEMENT.                 :rem 23
```

```
930 PRINT"{CLR}":RETURN                :rem 26
1000 REM HISTORICAL FIGURES            :rem 172
1001 DATA THE FIRST PRESIDENT,GEORGE WASH
     INGTON                            :rem 218
1002 DATA FIRST CHIEF JUSTICE,JOHN JAY
                                       :rem 26
1003 DATA WHO INVENTED COTTON GIN,ELI WHI
     TNEY                              :rem 12
1004 DATA PRESIDENT OF CONFEDERACY,JEFFER
     SON DAVIS                         :rem 138
1005 DATA WHO DEBATED LINCOLN?,STEPHEN DO
     UGLAS                             :rem 87
1006 DATA FAMOUS ABOLITIONIST,FREDERICK D
     OUGLASS                           :rem 90
1007 DATA BRITISH NAVIGATOR,FRANCIS DRAKE
                                       :rem 59
1008 DATA THE THIRD PRESIDENT,THOMAS JEFF
     ERSON                             :rem 135
1009 DATA HE PRESIDED OVER THE NEW DEAL,F
     RANKLIN DELANO ROOSEVELT          :rem 213
1010 DATA WHO WAS ASSASSINATED IN DALLAS?
     ,JOHN F. KENNEDY                  :rem 156
1011 DATA RAILROAD MAGNATE,CORNELIUS VAND
     ERBILT                            :rem 243
2000 REM WORLD CITIES                  :rem 239
2001 DATA WHAT IS THE CAPITAL OF JAPAN?,T
     OKYO                              :rem 140
2002 DATA WHERE IS TRAFALGAR SQUARE?,LOND
     ON                                :rem 143
2003 DATA WHERE IS THE WESTERN WALL?,JERU
     SALEM                             :rem 66
2004 DATA WHERE IS THE COLISEUM?,ROME
                                       :rem 215
2005 DATA WHERE IS RED SQUARE?,MOSCOW
                                       :rem 231
2006 DATA WHERE IS THE TAJ MAHAL?,AGRA
                                       :rem 162
2007 DATA WHAT IS THE CAPITAL OF AFGHANIS
     TAN?,KABUL                        :rem 37
2008 DATA THE PARTHENON IS IN THIS CITY,A
     THENS                             :rem 7
2009 DATA CITY LEASED 8Y ENGLAND FROM CHI
     NA,HONG KONG                      :rem 126
2010 DATA WHERE IS THE LINCOLN MEMORIAL?,
     WASHINGTON                        :rem 167
2011 DATA THIS CITY IS FAMOUS FOR ITS CAN
     ALS,VENICE                        :rem 37
3000 REM NEWSMAKERS                    :rem 167
3001 DATA PRESIDENT OF FRANCE,MITTERAND
                                       :rem 164
3002 DATA FORMER SECRETARY OF STATE UNDER
      REAGAN,HAIG                      :rem 227
3003 DATA SOVIET FOREIGN MINISTER,GROMYKO
                                       :rem 131
3004 DATA GERMAN CHANCELLOR,KOHL       :rem 208
3005 DATA SECRETARY OF TREASURY,REGAN
                                       :rem 65
3006 DATA CHAIRMAN OF SOVIET COMMUNIST PA
     RTY,CHERNENKO                     :rem 173
3007 DATA CANADIAN PRIME MINISTER,TRUDEAU
                                       :rem 65
3008 DATA JAPANESE PRIME MINISTER,NAKASON
     E                                 :rem 144
3009 DATA SECRETARY OF STATE,SHULTZ
                                       :rem 196
3010 DATA MAYOR OF NEW YORK,KOCH       :rem 123
3011 DATA 8RITISH PRIME MINISTER,THATCHER
                                       :rem 91
4000 REM COMPUTERS                     :rem 106
4001 DATA THE BRAIN OF THE COMPUTER IS CA
     LLED,CENTRAL PROCESSING UNIT:rem 196
4002 DATA THE FASTEST WAY TO PROCESS DATA
     ,MACHINE LANGUAGE                 :rem 13
4003 DATA A SIMPLE COMPUTER LANGUAGE,8ASI
     C                                 :rem 45
4004 DATA USES REVERSE POLISH NOTATION,FO
     RTH                               :rem 40
4005 DATA 8 BITS ON THE 6502,8YTE:rem 248
4006 DATA A 16-BIT MICROPROCESSOR,68000
                                       :rem 252
4007 DATA TRANSFER DATA FROM MEMORY TO CP
     U,BUS                             :rem 18
4008 DATA DATA ARE PUSHED AND PULLED HERE
     ,STACK                             :rem 0
4009 DATA USED FOR INDEXING,X REGISTER
                                       :rem 62
4010 DATA FASTEST COMPUTATIONS TAKE PLACE
      HERE,PAGE ZERO                   :rem 214
4011 DATA A NUM8ERING SYSTEM,HEXADECIMAL
                                       :rem 238
5000 DATA HISTORICAL FIGURES,WORLD CITIES
     ,NEWSMAKERS,COMPUTERS             :rem 117
```

Program 3: The Tester, TI-99/4A Version

```
100 REM  EXTENDED BASIC NOT REQUIRE
    D
110 DIM QA$(44),AN$(44)
112 CALL CLEAR
114 FOR I=1 TO 44
120 READ QA$(I),AN$(I)
122 NEXT I
123 SUBJ=4
124 REM  SET SUBJ TO # OF CATEGORIE
    S OF QUESTIONS
125 FOR J=1 TO SUBJ
126 Q(J)=10
128 READ TL$(J)
129 NEXT J
200 CALL CLEAR
202 PRINT "PLEASE CHOOSE ONE SUBJEC
    T:"::
210 FOR I=1 TO 4
212 PRINT I;") ";TL$(I)
214 NEXT I
220 PRINT
222 PRINT "YOUR CHOICE";
224 INPUT N
226 IF (N<1)+(N>4)THEN 224
230 PRINT ::::
232 INPUT "HOW MANY QUESTIONS ?":N1
234 IF N1=0 THEN 232
300 TL=N1
302 SC=0
304 FOR CT=1 TO TL
306 CALL CLEAR
308 PRINT TL$(N);" TEST"
310 RANDOMIZE
312 ANS=INT(RND*Q(N))+(N*11)-10
314 PRINT ::
316 PRINT QA$(ANS)
320 FOR I=0 TO 3
322 GOSUB 800
324 J=0
330 IF (I=J)+(T(I)<>T(J))THEN 335
332 GOSUB 800
333 J=0
334 GOTO 330
335 J=J+1
337 IF J<=3 THEN 330
340 NEXT I
```

```
341 RANDOMIZE
342 J=1+INT(RND*5)
344 A=0
346 PRINT ::
348 FOR I=1 TO 5
349 PRINT I;") ";
350 IF I=J THEN 360
352 PRINT AN$(T(A))
354 A=A+1
356 GOTO 370
360 PRINT AN$(ANS)
370 NEXT I
372 PRINT
380 PRINT
382 INPUT "ENTER YOUR ANSWER: ":N1
390 IF (N1<1)+(N1>5)THEN 380
395 IF N1<>J THEN 430
400 SC=SC+1
402 PRINT
404 PRINT TAB(9);"GOOD !"
406 FOR I=1 TO 500
408 NEXT I
410 GOTO 460
430 PRINT
432 PRINT "SORRY, THE ANSWER IS:"
434 PRINT AN$(ANS)
440 PRINT
442 PRINT "HIT <ENTER> TO CONTINUE"
450 INPUT Z$
460 NEXT CT
500 CALL CLEAR
502 PRINT TL$(N)
510 PRINT ::::
512 PRINT "TOTAL QUESTIONS ";TL
514 PRINT "CORRECT ANSWERS ";SC
520 PRINT "YOUR SCORE IS ON THE ";T
    L$(N);" TEST IS";INT((SC/TL)*10
    0+.5);"%."
530 PRINT
532 INPUT "WANT ANOTHER TEST (Y/N)?
    ";Z$
534 IF (Z$<>"Y")*(Z$<>"N")THEN 530
550 IF Z$="Y" THEN 200
560 CALL CLEAR
562 STOP
800 RANDOMIZE
801 T(I)=INT(RND*Q(N))+(N*11)-10
802 IF T(I)=ANS THEN 800
810 RETURN
1000 REM  HISTORICAL FIGURES
1001 DATA THE FIRST PRESIDENT,GEORG
     E WASHINGTON
1002 DATA FIRST CHIEF JUSTICE,JOHN
     JAY
1003 DATA INVENTED THE COTTON GIN,E
     LI WHITNEY
1004 DATA PRESIDENT OF CONFEDERACY,
     JEFFERSON DAVIS
1005 DATA WHO DEBATED LINCOLN?,STEP
     HEN DOUGLAS
1006 DATA FAMOUS ABOLITIONIST,FREDE
     RICK DOUGLASS
1007 DATA BRITISH NAVIGATOR,FRANCIS
      DRAKE
1008 DATA THE THIRD PRESIDENT,THOMA
     S JEFFERSON
1009 DATA HE PRESIDED OVER THE NEW
     DEAL,F. D. ROOSEVELT
1010 DATA WHO WAS ASSASSINATED IN D
     ALLAS?,JOHN F. KENNEDY
1011 DATA RAILROAD MAGNATE,CORNELIU
     S VANDERBILT
2000 REM  WORLD CITIES
2001 DATA WHAT IS THE CAPITAL OF JA
     PAN?,TOKYO
2002 DATA WHERE IS TRAFALGAR SQUARE
     ?,LONDON
2003 DATA WHERE IS THE WESTERN WALL
     ?,JERUSALEM
2004 DATA WHERE IS THE COLISEUM?,RO
     ME
2005 DATA WHERE IS THE RED SQUARE?,
     MOSCOW
2006 DATA WHERE IS THE TAJ MAHAL?,A
     GRA
2007 DATA WHERE IS THE CAPITAL OF A
     FGHANISTAN?,KABUL
2008 DATA THE PARTHENON IS IN THIS
     CITY,ATHENS
2009 DATA CITY LEASED BY ENGLAND FR
     OM CHINA,HONG KONG
2010 DATA WHERE IS THE LINCOLN MEMO
     RIAL?,WASHINGTON
2011 DATA THIS CITY IS FAMOUS FOR I
     TS CANALS,VENICE
3000 REM  NEWSMAKERS
3001 DATA PRESIDENT OF FRANCE,MITTE
     RAND
3002 DATA FORMER SECRETARY OF STATE
      UNDER REAGAN,HAIG
3003 DATA SOVIET FOREIGN MINISTER,G
     ROMYKO
3004 DATA GERMAN CHANCELLOR,KOHL
3005 DATA SECRETARY OF TREASURY,REG
     AN
3006 DATA CHAIRMAN OF SOVIET COMMUN
     IST PARTY,CHERNENKO
3007 DATA CANADIAN PRIME MINISTER,T
     RUDEAU
3008 DATA JAPANESE PRIME MINISTER,N
     AKASONE
3009 DATA SECRETARY OF STATE,SHULTZ
3010 DATA MAYOR OF NEW YORK,KOCH
3011 DATA BRITISH PRIME MINISTER,TH
     ATCHER
4000 REM  COMPUTERS
4001 DATA THE BRAIN OF THE COMPUTER
      IS CALLED,CENTRAL PROCESSING
     UNIT
4002 DATA THE FASTEST WAY TO PROCES
     S DATA,MACHINE LANGUAGE
4003 DATA A SIMPLE COMPUTER LANGUAG
     E,BASIC
4004 DATA USES REVERSE POLISH NOTAT
     ION,FORTH
4005 DATA 8 BITS ON THE 6502,BYTE
4006 DATA A 16-BIT MICROPROCESSOR,6
     8000
4007 DATA TRANSFER DATA FROM MEMORY
      TO CPU,BUS
4008 DATA DATA ARE PUSHED AND PULLE
     D HERE,STACK
4009 DATA USED FOR INDEXING,X REGIS
     TER
4010 DATA FASTEST COMPUTATIONS TAKE
      PLACE HERE,PAGE ZERO
4011 DATA A NUMBERING SYSTEM,HEXADE
     CIMAL
5000 DATA HISTORICAL FIGURES,WORLD
     CITIES,NEWSMAKERS,COMPUTERS ©
```

A Beginner's Guide To Typing In Programs

What Is A Program?

A computer cannot perform any task by itself. Like a car without gas, a computer has *potential*, but without a program, it isn't going anywhere. Most of the programs published in COMPUTE! are written in a computer language called BASIC. BASIC is easy to learn and is built into most computers (on some computers, you have to purchase an optional BASIC cartridge).

BASIC Programs

Each month, COMPUTE! publishes programs for many machines. To start out, type in only programs written for your machine, e.g., "TI Version" if you have a TI-99/4. Later, when you gain experience with your computer's BASIC, you can try typing in and converting certain programs from one computer to yours.

Computers can be picky. Unlike the English language, which is full of ambiguities, BASIC usually has only one "right way" of stating something. Every letter, character, or number is significant. A common mistake is substituting a letter such as O for the numeral 0, a lowercase l for the numeral 1, or an uppercase B for the numeral 8. Also, you must enter all punctuation such as colons and commas just as they appear in the magazine. Spacing can be important. To be safe, type in the listings *exactly* as they appear.

Braces And Special Characters

The exception to this typing rule is when you see the braces, such as {DOWN}. Anything within a set of braces is a special character or characters that cannot easily be listed in a printer. When you come across such a special statement, refer to the appropriate key for your computer. For example, if you have an Atari, refer to the "Atari" section in "How To Type COMPUTE!'s Programs."

About DATA Statements

Some programs contain a section or sections of DATA statements. These lines provide information needed by the program. Some DATA statements contain actual programs (called machine language); others contain graphics codes. These lines are especially sensitive to errors.

If a single number in any one DATA statement is mistyped, your machine could "lock up," or "crash." The keyboard, break key, and RESET (or STOP) keys may all seem "dead," and the screen may go blank. Don't panic – no damage is done. To regain control, you have to turn off your computer, then turn it back on. This will erase whatever program was in memory, so always SAVE a copy of your program before you RUN it. If your computer crashes, you can LOAD the program and look for your mistake.

Sometimes a mistyped DATA statement will cause an error message when the program is RUN. The error message may refer to the program line that READs the data. *The error is still in the DATA statements, though.*

Get To Know Your Machine

You should familiarize yourself with your computer before attempting to type in a program. Learn the statements you use to store and retrieve programs from tape or disk. You'll want to save a copy of your program, so that you won't have to type it in every time you want to use it. Learn to use your machine's editing functions. How do you change a line if you made a mistake? You can always retype the line, but you at least need to know how to backspace. Do you know how to enter inverse video, lowercase, and control characters? It's all explained in your computer's manuals.

A Quick Review

1. Type in the program a line at a time, in order. Press RETURN or ENTER at the end of each line. Use backspace or the back arrow to correct mistakes.

2. Check the line you've typed against the line in the magazine. You can check the entire program again if you get an error when you RUN the program.

3. Make sure you've entered statements in braces as the appropriate control key (see "How To Type COMPUTE!'s Programs" elsewhere in the magazine).

We regret that we are no longer able to respond to individual inquiries about programs, products, or services appearing in COMPUTE! *due to increasing publication activity. On those infrequent occasions when a published program contains a typo, the correction will appear on the CAPUTE! page, usually within eight weeks. If you have specific questions about items or programs which you've seen in* COMPUTE!, *please send them to Readers' Feedback, P.O. Box 5406, Greensboro, NC 27403.* ©

How To Type COMPUTE!'s Programs

Many of the programs which are listed in COMPUTE! contain special control characters (cursor control, color keys, inverse video, etc.). To make it easy to tell exactly what to type when entering one of these programs into your computer, we have established the following listing conventions. There is a separate key for each computer. Refer to the appropriate tables when you come across an unusual symbol in a program listing. If you are unsure how to actually enter a control character, consult your computer's manuals.

Atari 400/800

Characters in inverse video will appear like: ▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯ Enter these characters with the Atari logo key, {A}.

When you see	Type	See	
{CLEAR}	ESC SHIFT <	▯	Clear Screen
{UP}	ESC CTRL -	▯	Cursor Up
{DOWN}	ESC CTRL =	▯	Cursor Down
{LEFT}	ESC CTRL +	▯	Cursor Left
{RIGHT}	ESC CTRL *	▯	Cursor Right
{BACK S}	ESC DELETE	▯	Backspace
{DELETE}	ESC CTRL DELETE	▯	Delete character
{INSERT}	ESC CTRL INSERT	▯	Insert character
{DEL LINE}	ESC SHIFT DELETE	▯	Delete line
{INS LINE}	ESC SHIFT INSERT	▯	Insert line
{TAB}	ESC TAB	▯	TAB key
{CLR TAB}	ESC CTRL TAB	▯	Clear tab
{SET TAB}	ESC SHIFT TAB	▯	Set tab stop
{BELL}	ESC CTRL 2	▯	Ring buzzer
{ESC}	ESC ESC	▯	ESCape key

Graphics characters, such as CTRL-T, the ball character ● will appear as the "normal" letter enclosed in braces, e.g. {T}.

A series of identical control characters, such as 10 spaces, three cursor-lefts, or 20 CTRL-R's, will appear as {10 SPACES}, {3 LEFT}, {20 R}, etc. If the character in braces is in inverse video, that character or characters should be entered with the Atari logo key. For example, {▯} means to enter a reverse-field heart with CTRL-comma, {5▯} means to enter five inverse-video CTRL-U's.

Commodore PET/CBM/VIC/64

Generally, any PET/CBM/VIC/64 program listings will contain words within braces which spell out any special characters: {DOWN} would mean to press the cursor down key. {5 SPACES} would mean to press the space bar five times.

To indicate that a key should be *shifted* (hold down the SHIFT key while pressing the other key), the key would be underlined in our listings. For example, S would mean to type the S key while holding the shift key. If you find an underlined key enclosed in braces (e.g., {10 N}), you should type the key as many times as indicated (in our example, you would enter ten shifted N's). Some graphics characters are inaccessible from the keyboard on CBM Business models (32N, 8032).

For the VIC and 64, if a key is enclosed in special brackets, [< >], you should hold down the *Commodore key* while pressing the key inside the special brackets. (The Commodore key is the key in the lower left corner of the keyboard.) Again, if the key is preceded by a number, you should press the key as many times as indicated.

Rarely, you'll see in a Commodore 64 program a solitary letter of the alphabet enclosed in braces. These characters can be entered by holding down the CTRL key while typing the letter in the braces. For example, {A} would indicate that you should press CTRL-A.

About the *quote mode*: you know that you can move the cursor around the screen with the CRSR keys. Sometimes a programmer will want to move the cursor under program control. That's why you see all the {LEFT}'s, {HOME}'s, and {BLU}'s in our programs. The only way the computer can tell the difference between direct and programmed cursor control is the quote mode.

Once you press the quote (the double quote, SHIFT-2), you are in the quote mode. If you type something and then try to change it by moving the cursor left, you'll only get a bunch of reverse-video lines. These are the symbols for cursor left. The only editing key that isn't programmable is the DEL key; you can still use DEL to back up and edit the line. Once you type another quote, you are out of quote mode.

You also go into quote mode when you INSerT spaces into a line. In any case, the easiest way to get out of quote mode is to just press RETURN. You'll then be out of quote mode and you can cursor up to the mistyped line and fix it.

Use the following tables when entering special characters:

VIC And 64

When You Read:	Press:		See:
{CLR}	SHIFT	CLR/HOME	▯
{HOME}		CLR/HOME	▯
{UP}	SHIFT	↑ CRSR	▯
{DOWN}		↓ CRSR	▯
{LEFT}	SHIFT	← CRSR	▯
{RIGHT}		→ CRSR	▯
{RVS}	CTRL	9	▯
{OFF}	CTRL	0	▯
{BLK}	CTRL	1	▯
{WHT}	CTRL	2	▯
{RED}	CTRL	3	▯
{CYN}	CTRL	4	▯
{PUR}	CTRL	5	▯

When You Read:	Press:		See:
{GRN}	CTRL	6	▯
{BLU}	CTRL	7	▯
{YEL}	CTRL	8	▯
{F1}	f1		▯
{F2}	f2		▯
{F3}	f3		▯
{F4}	f4		▯
{F5}	f5		▯
{F6}	f6		▯
{F7}	f7		▯
{F8}	f8		▯
←	←		▯
↑	SHIFT	↑	▯

All Commodore Machines

Clear Screen	{CLR}	Cursor Left	{LEFT}
Home Cursor	{HOME}	Insert Character	{INST}
Cursor Up	{UP}	Delete Character	{DEL}
Cursor Down	{DOWN}	Reverse Field On	{RVS}
Cursor Right	{RIGHT}	Reverse Field Off	{OFF}

Apple II / Apple II Plus

All programs are in Applesoft BASIC, unless otherwise stated. Control characters are printed as the "normal" character enclosed in braces, such as {D} for CTRL-D. Hold down CTRL while pressing the control key. You will not see the special character on the screen.

Texas Instruments 99/4

The only special characters used are in PRINT statements to indicate where two or more spaces should be left between words. For example, ENERGY {10 SPACES} MANAGEMENT means that ten spaces should be left between the words ENERGY and MANAGEMENT. Do not type in the braces or the words 10 SPACES. Enter all programs with the ALPHA LOCK on (in the down position). Release the ALPHA LOCK to enter lowercase text.

The Automatic Proofreader
For VIC, 64, And Atari

Charles Brannon, Program Editor

At last there's a way for your computer to help you check your typing. "The Automatic Proofreader" will make entering programs faster, easier, and more accurate.

The strong point of computers is that they excel at tedious, exacting tasks. So why not get your computer to check your typing for you?

With "The Automatic Proofreader" nestled in your VIC-20, Commodore 64, or Atari computer, every line you type in will be verified. It displays a special code, called a *checksum*, at the top of the screen. The checksum, either a number (VIC/64) or a pair of letters (Atari), corresponds to the line you've just typed. It represents every character in the line summed together. A matching code in the program listing lets you compare it to the checksum which the Proofreader displays. A glance is all it takes to confirm that you've typed the line correctly.

Entering The Automatic Proofreader

Commodore (VIC/64) owners should type in Program 1. Program 2 is for Atari users. Since the Proofreader is a machine language program, be especially diligent. Watch out for typing extra commas, or a letter O for a zero, and check every number carefully. If you make a mistake when typing in the DATA statements, you'll get the message "Error in DATA statements" when you RUN the program. Check your typing and try again.

When you've typed in The Automatic Proofreader, SAVE it to tape or disk at least twice *before running it for the first time*. If you mistype the Proofreader, it may cause a system crash when you first run it. By SAVEing a copy beforehand, you can reLOAD it and hunt for your error. Also, you'll want a backup copy of the Proofreader because you'll use it again and again—every time you enter a program from COMPUTE!.

When you RUN the Proofreader, the program will be POKEd safely into memory, then it will activate itself. If you ever need to reactivate it (RUN/STOP—RESTORE or SYSTEM RESET will disable it), just enter the command SYS 886 (VIC/64) or PRINT USR(1536) for the Atari.

Using The Proofreader

Now, let's see how it works. LIST the Proofreader program, move the cursor up to one of the lines, and press RETURN. If you've entered the Proofreader correctly, a checksum will appear in the top-left corner of your screen.

Try making a change in the line and hit RETURN. Notice that the checksum has changed. All VIC and 64 listings in COMPUTE! now have a number appended to the end of each line, for example, :rem 123. *Don't enter this statement.* It is just for your information. The rem is used to make the number harmless if someone does type it in. It will, however, use up memory if you enter it, and it will cause the checksum displayed at the top of the screen to be different, even if you entered the rest of the line correctly.

The Atari checksum is found immediately to the left of each line number. This makes it impossible to type in the checksum accidentally, since a program line must start with a number.

Just type in each line (without the printed checksum), and check the checksum displayed at the top of the screen against the checksum in the listing. If they match, go on to the next line. If they don't, there's a mistake. You can correct the line immediately, instead of waiting to find the error when you RUN the program.

The Proofreader is not picky with spaces. It will not notice extra spaces or missing ones. This is for your convenience, since spacing is generally not important. Occasionally proper spacing is important, but the article describing the program will warn you to be careful in these cases.

Nobody's Perfect

Although the Proofreader is an important aid, there are a few things to watch out for. If you enter a line by using abbreviations for commands, the checksum will not match up. This is because the Proofreader is very literal: It looks at the individual letters in a line, not at tokens such as PRINT. There is a way to make the Proofreader check such a line. After entering the line, LIST it. This makes the computer spell out the abbreviations. Then move the cursor up to the line and press RETURN. It should now match the checksum. You can check whole groups of lines this way. Atari users should beware of using ? as an abbreviation for PRINT—they're not the same thing in the Proofreader's eyes.

The checksum is a sum of the ASCII values of the characters in a line. VIC and 64 owners may wonder why the numbers are so small, never exceeding 255. This is because the addition is done only in eight bits. A result over 255 will roll over past zero, like an odometer past 99999. On the Atari, the number is turned into two letters, both for increased convenience and to make the Proofreader shorter. For the curious, the letters correspond to the values of the left and right nybbles added to 33 (to offset them into the alphabet). This number is then stored directly into screen memory.

Due to the nature of a checksum, the Proofreader will not catch all errors. Since 1+3+5=3+1+5, the Proofreader cannot catch errors of transposition. In fact, you could type in the line in any order, and the Proofreader wouldn't notice. Anytime the Proofreader

seems to act strange, keep this in mind. Since the ASCII values of the number 18 (49+56) and 63 (54+51) both equal 105, these numbers are equal according to the Proofreader. There really is no simple way to catch these kinds of errors. Fortunately, the Proofreader will catch the majority of the typing mistakes most people make.

If you want the Proofreader out of your way, just press SYSTEM RESET or RUN/STOP—RESTORE. If you need it again, enter SYS 828 (VIC/64) or PRINT USR(1536) (Atari). You must disable the Proofreader before doing any tape operations on the VIC or 64.

Hidden Perils

The Proofreader's home in the VIC and 64 is not a very safe haven. Since the cassette buffer is wiped out during tape operations, you need to disable the Proofreader with RUN/STOP—RESTORE before you SAVE your program. This applies only to tape use. Disk users or Atari owners have nothing to worry about.

Not so for VIC and 64 owners with tape drives. What if you type in a program in several sittings? The next day, you come to your computer, LOAD and RUN the Proofreader, then try to LOAD the partially completed program so you can add to it. But since the Proofreader is trying to hide in the cassette buffer, it is wiped out!

What you need is a way to LOAD the Proofreader after you've LOADed the partial program. The problem is, a tape load to the buffer destroys what it's supposed to load.

After you've typed in and RUN the Proofreader, enter the following lines in direct mode (without line numbers) *exactly* as shown:

```
A$="PROOFREADER.T": B$="{10 SPACES}": FOR
   X = 1 TO 4: A$=A$+B$: NEXTX
FOR X = 886 TO 1018: A$=A$+CHR$(PEEK(X)):
   NEXTX
OPEN 1,1,1,A$:CLOSE1
```

After you enter the last line, you will be asked to press record and play on your cassette recorder. Put this program at the beginning of a new tape. This gives you a new way to load the Proofreader. Anytime you want to bring the Proofreader into memory without disturbing anything else, put the cassette in the tape drive, rewind, and enter:

```
OPEN1:CLOSE1
```

You can now start the Proofreader by typing SYS 886. To test this, PRINT PEEK(886) should return the number 173. If it does not, repeat the steps above, making sure that A$ ("PROOFREADER.T") contains 13 characters and that B$ contains 10 spaces.

You can now reload the Proofreader into memory whenever LOAD or SAVE destroys it, restoring your personal typing helper.

Incidentally, you can protect the cassette buffer on the Commodore 64 with POKE 178,251. This POKE should work on the VIC, but it has caused numerous problems, probably due to a bug in the VIC operating system. With this POKE, the 64 will not wipe out the cassette buffer during tape LOADs and SAVEs.

Program 1: VIC/64 Proofreader

```
100 PRINT"{CLR}PLEASE WAIT...":FORI=886TO
    1018:READA:CK=CK+A:POKEI,A:NEXT
110 IF CK<>17539 THEN PRINT"{DOWN}YOU MAD
    E AN ERROR":PRINT"IN DATA STATEMENTS.
    ":END
120 SYS886:PRINT"{CLR}{2 DOWN}PROOFREADER
     ACTIVATED.":NEW
886 DATA 173,036,003,201,150,208
892 DATA 001,096,141,151,003,173
898 DATA 037,003,141,152,003,169
904 DATA 150,141,036,003,169,003
910 DATA 141,037,003,169,000,133
916 DATA 254,096,032,087,241,133
922 DATA 251,134,252,132,253,008
928 DATA 201,013,240,017,201,032
934 DATA 240,005,024,101,254,133
940 DATA 254,165,251,166,252,164
946 DATA 253,040,096,169,013,032
952 DATA 210,255,165,214,141,251
958 DATA 003,206,251,003,169,000
964 DATA 133,216,169,019,032,210
970 DATA 255,169,018,032,210,255
976 DATA 169,058,032,210,255,166
982 DATA 254,169,000,133,254,172
988 DATA 151,003,192,087,208,006
994 DATA 032,205,189,076,235,003
1000 DATA 032,205,221,169,032,032
1006 DATA 210,255,032,210,255,173
1012 DATA 251,003,133,214,076,173
1018 DATA 003
```

Program 2: Atari Proofreader

```
100 GRAPHICS 0
110 FOR I=1536 TO 1700:READ A:POKE I
    ,A:CK=CK+A:NEXT I
120 IF CK<>19072 THEN ? "Error in DA
    TA statements. Check typing":END

130 A=USR(1536)
140 ? :? "Automatic Proofreader now
    activated."
150 END
1536 DATA 104,160,0,185,26,3
1542 DATA 201,69,240,7,200,200
1548 DATA 192,34,208,243,96,200
1554 DATA 169,74,153,26,3,200
1560 DATA 169,6,153,26,3,162
1566 DATA 0,189,0,228,157,74
1572 DATA 6,232,224,16,208,245
1578 DATA 169,93,141,78,6,169
1584 DATA 6,141,79,6,24,173
1590 DATA 4,228,105,1,141,95
1596 DATA 6,173,5,228,105,0
1602 DATA 141,96,6,169,0,133
1608 DATA 203,96,247,238,125,241
1614 DATA 93,6,244,241,115,241
1620 DATA 124,241,76,205,238,0
1626 DATA 0,0,0,0,32,62
1632 DATA 246,8,201,155,240,13
1638 DATA 201,32,240,7,72,24
1644 DATA 101,203,133,203,104,40
1650 DATA 96,72,152,72,138,72
1656 DATA 160,0,169,128,145,88
1662 DATA 200,192,40,208,249,165
1668 DATA 203,74,74,74,74,24
1674 DATA 105,161,160,3,145,88
1680 DATA 165,203,41,15,24,105
1686 DATA 161,200,145,88,169,0
1692 DATA 133,203,104,170,104,168
1698 DATA 104,40,96
```

©

Missile Math

Garry S. Wick

Educational programs are usually designed to reward correct answers. "Missile Math" does this, but also gives extra points for speed. Here's an entertaining way for young students to learn their math. Versions for the Atari, Commodore VIC-20 and 64, the TI-99/4A, Apple, and IBM PC/PCjr.

"Missile Math" starts with an animated introduction screen, then a joystick-controlled menu appears on the screen. You have a choice of addition and subtraction or multiplication and division at a slow or fast speed. Using the joystick to select the menu item eliminates possible errors from incorrect typing. The joystick does not give any unacceptable entries when the fire button is pressed to start the game.

Different Difficulty Levels

After a short pause for the initialization of the player/missile figures, the player sees a screen that displays ENTERING LEVEL 1. As you advance from one level to the next, the math problems become increasingly difficult.

The problem appears at the top of the screen. On the bottom there are five possible answers, together with a missile gun which you control with the joystick. The object is to position the gun over the correct answer and launch a missile so that it destroys an enemy spaceship as it traverses the screen. On the upper left corner of the screen are spades representing the number of remaining guns. You begin with three guns. The score is displayed in the upper right corner of the screen.

A special kind of problem appears in random locations. For example, you could see 3+4=? or 3+?=7 or ?+4=7. Addition and subtraction are combined. It is similar for multiplication and division. The correct answer randomly appears in one of five possible locations, so the player never knows in advance where to position the gun. The values of the incorrect answers are chosen so that the correct answer is not obvious. This discourages guessing.

A Feisty UFO

The UFO moves across the screen at three different heights. The first height is near the top of the screen, and on the two successive flights, the UFO moves closer to the position of the gun. Of course, if the player destroys the UFO on the first pass, it does not appear at the lower altitudes. Instead a new problem appears, and the UFO starts again at the highest position.

It is most difficult to destroy the UFO at the highest altitude because there is less time to calculate the correct answer and to fire the missile at the right time to hit the UFO. Destroying the UFO at the middle altitude is easier, and at the lowest altitude, it is easiest. Thus the player gets 25 points for a correct hit on the first pass, 10 points for the second pass, and 5 points for the third pass. When the gun is positioned over the correct answer and scores a hit, the UFO explodes with sound effects, disappears, and the number of points earned appears in its place. Then a new problem appears on the screen.

If you score a direct hit on the UFO, but have the gun over an incorrect answer, the UFO briefly changes colors, makes a funny sound and continues on its way. You must then try again on the next pass of the UFO. Three consecutive misses or incorrect answers and the UFO destroys the gun and one of the spades disappears. Sound effects accompany the disappearance of the spade and the correct answer blinks on and off as an encouraging message flies onto the screen. The game ends when all three guns have been destroyed.

To advance to the next level, you must score 50 points. If the present level is too easy, you can enter the next level by solving as few as two problems, receiving 25 points for each correct answer. If you only succeed in destroying the UFO on its third pass each time, then you will have to solve ten problems before moving to the next level. Thus you get more practice on problems that stretch your abilities. You can quickly pass by the problems that you find easy.

Bonus Points

You can earn the 50 points necessary to advance to higher levels with any combination of 5, 10, or 25 points, but you can earn bonus points for speed and accuracy. If the average score for the problems solved in a level is 25, the player receives 50 bonus points. The only way to get 50 bonus points is to score correct hits on the first two problems in a level during the first pass of

the UFO. If you average ten points or better per problem (but less than 25), you will earn 25 bonus points. There are no bonus points if you average less than ten points per problem. Bonus points are displayed with suitable fanfare.

There are a few features of Program 1 that require special mention. The joystick-controlled menu appears in Program 1 at lines 5000 through 5230. It uses screen memory locations to identify the choices available so that it is impossible to make an incorrect entry and cause an error.

Player/Missile Machine Language

The UFO is Atari Player 1 and the explosion character is Player 3. In order to rapidly exchange them when a correct hit has occurred, it is necessary that the two players always be at the same vertical position. (Then it is easy to POKE the UFO horizontally off the screen and to POKE the explosion at the former position of the UFO.)

BASIC was too slow to move both players vertically. A machine language program to move two players vertically lower on the screen is in lines 4000–4060. The parameters for the current location and length of the players are set by the subroutine at line 3500.

It is a little tricky and not at all obvious how to determine when the gun is over the correct answer. The playfield characters (the answers) and the players use different coordinate systems. It is necessary to establish an equation that maps one coordinate system to the other. The appropriate equations are:

X(P/M) = 4*X(Playfield) + 45
Y(P/M) = 4*Y(Playfield) + 17

where X and Y are the horizontal and vertical coordinates respectively. The X equation is used in line 2510 to determine whether the gun is over the correct answer, and the Y equation is used in line 3025 to position the number of points earned at the same height as the explosion of the UFO.

Program 1: Atari Missile Math

Refer to the "Automatic Proofreader" article before typing this program in

```
JB 10 DIM M$(20),MIS$(13),BL$(40),A$
      (6),B$(6),C$(6),CH(5),KEEP$(21)
HL 15 GRAPHICS 2+16
BD 20 BL$=" ":BL$(20)=" ":BL$(2)=BL$
DB 30 MIS$="MISSILE MATH "
AK 60 FOR I=1 TO 15
BK 70 BL$(20-I,20)=MIS$
AI 80 SOUND 0,75-I,8,I
PA 90 POSITION 0,5:? #6;BL$:NEXT I
HM 100 RESTORE 110:FOR I=1 TO 35:REA
       D A:SOUND 0,A,10,8:FOR J=1 TO
        45:NEXT J:NEXT I
```

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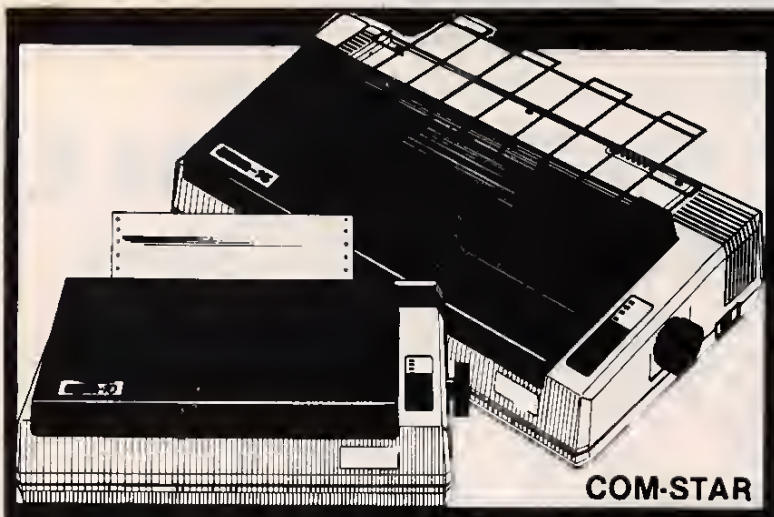

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```
PE 110 DATA 81,81,81,60,60,60,60,60,
      60,60,60,60,81,81,81,60,68,72
      ,81,81,81,81,81,81,81
CP 111 DATA 0,81,81,81,81,60,60,60,6
      0,60,60,60
DJ 120 FOR I=0 TO 15
JG 130 8L$=8L$(2,20-I):SOUND 0,75-I,
      8,I
CD 140 POSITION 0,5:? #6;8L$:NEXT I:
      SOUND 0,0,0,0
DA 150 FOR I=1 TO 250:NEXT I
NL 160 GOSUB 4000
NN 170 GOSUB 5000
NI 175 ? CHR$(125):? :? :? "TO PLAY:
      ":? "POSITION GUN OVER CORREC
      T ANSWER":? "AND SHOOT THE UF
      O."
GD 180 ? :? :? "BE CAREFUL NOT TO WA
      STE SHOTS."
DL 185 ? :? :? :? :? "PLEASE WAIT A
      MOMENT....."
NN 200 GOSUB 5500
CN 210 LVL=1:SC=0:NP=3:HIT=0:GUN=0:X
      1=165
NN 220 ? CHR$(125):POKE 752,1:POSITI
      ON 12,10:SETCOLOR 2,2,10:SETC
      OLOR 1,2,0:? "ENTERING LEVEL
      ";LVL
CB 225 PB=0:SCL=0
IF 226 RESTORE 110:FOR I=1 TO 35:REA
      D A:SOUND 0,A,10,8:FOR J=1 TO
       20:NEXT J:NEXT I:SOUND 0,0,0
      ,0
JE 230 A=INT(RND(0)*4+1)+4*(LVL-1)
IN 235 B=INT(RND(0)*4*LVL+1)
DE 240 IF MENU=1 THEN C=A+B:GOTO 255
ME 250 C=A*B
AJ 255 A$=STR$(A):B$=STR$(B):C$=STR$
      (C)
NC 260 RP=INT(RND(0)*4)+1
FD 270 IF RP=1 THEN ANS=A:A$=CHR$(63
      )
GC 280 IF RP=2 THEN ANS=B:B$=CHR$(63
      )
BK 290 IF RP=3 OR RP=4 THEN ANS=C:C$
      =CHR$(63)
GD 295 FOR I=1 TO 500:NEXT I:? CHR$(
      125):POSITION 13,5:SETCOLOR 1
      ,0,14:SETCOLOR 2,0,2
EJ 300 IF MENU=1 THEN ? A$;" + ";B$;
      " = ";C$:GOTO 320
AD 310 ? A$;" X ";B$;" = ";C$
EJ 320 FOR I=1 TO NP:POSITION 2*I,2:
      ? CHR$(123):NEXT I
NC 340 POSITION 25,2:? "SCORE ";SC:P
      B=PB+1
GC 345 IF ANS>90 THEN DEL=10:GOTO 36
      0
DA 346 IF ANS>20 THEN DEL=5:GOTO 360
AF 350 DEL=INT((ANS/10)+1)
NK 360 DT=INT(RND(0)*5)+1
FD 370 FOR I=1 TO 5:CH(I)=ANS+(I-DT)
      *DEL:POSITION 6*I,21:? CH(I):
      NEXT I
DH 375 GOSUB 3500
NG 380 POKE 53278,1:SHT=0
AN 390 FOR X0=200 TO 25 STEP -DX:POK
      E 53248,X0
DC 400 ST=STICK(0):X1=X1+4*((ST=7)+(
      X1<210)):X1=X1-4*((ST=11)+(X1
      >40)):POKE 53249,X1
BN 410 IF STRIG(0)=0 AND SHT=0 THEN
      GUN=1:POKE PM8ASE+384+Y1,0:Y1
      =102:XM1=X1+7:POKE 53253,XM1:
      SHT=1
PC 415 IF GUN=1 THEN GOSUB 2000
AE 420 IF HIT=1 THEN HIT=0:GOTO 440
CE 430 NEXT X0:POKE 53253,250:SOUND
      0,0,0,0:GUN=0
GD 435 GOTO 450
NH 440 IF SCL>=50 THEN LVL=LVL+1:POK
      E 53249,250:GOTO 220
JD 445 POKE 53249,250:GOTO 230
DD 450 GOSUB 3700
IC 460 IF Y0<100 THEN GOTO 380
AN 470 FOR X0=205 TO 30 STEP -DX:POK
      E 53248,X0
EO 480 IF PEEK(53260)<>2 THEN NEXT X
      0
DE 490 POKE 53248,250:POKE 53249,250
      :POKE 53250,X0
NP 500 GOSUB 2800
EN 530 POSITION 2*NP,2:? "*"
IB 540 FOR I=1 TO 30:SOUND 0,250-4*I
      ,10,8:NEXT I:SOUND 0,0,0,0
DB 550 POSITION 2*NP,2:? "  ":FOR I=
      15 TO 0 STEP -1:SOUND 0,100,0
      ,I:NEXT I
HC 560 NP=NP-1
EC 565 FOR I=1 TO 10
FF 570 POSITION 6*DT,21:? "
      {4 SPACES}"
FK 575 K=INT(RND(0)*15)
KI 580 FOR J=40 TO 25 STEP -1:SOUND
      0,J-K,10,8:NEXT J
PF 590 POSITION 6*DT,21:? ANS
FN 600 K=INT(RND(0)*15):FOR J=40 TO
      25 STEP -1:SOUND 0,J-K,10,8:N
      EXT J:NEXT I:SOUND 0,0,0,0
FB 610 8L$=" ":8L$(38)=" ":8L$(2)=8L$
GE 620 KEEP$="KEEP TRYING "
HK 630 FOR I=1 TO 23:8L$(38-I,38)=KE
      EP$
GD 640 SOUND 0,90-I,8,INT(I/2)+3:POS
      ITION 0,9:? BL$:NEXT I
FF 650 8L$=" ":8L$(38)=" ":8L$(2)=8L
      $
ON 660 KEEP$="I KNOW YOU CAN DO IT "
ID 670 FOR I=1 TO 28:BL$(38-I,38)=KE
      EP$
FK 680 SOUND 0,100-I,8,INT(I/2):POSI
      TION 0,11:? 8L$:NEXT I
IJ 690 RESTORE 110:FOR I=1 TO 35:REA
      D A:SOUND 0,A,10,8:FOR J=1 TO
       10:NEXT J:NEXT I:SOUND 0,0,0
      ,0
DG 700 IF NP=0 THEN GOTO 715
GN 710 SOUND 0,0,0,0:GOTO 230
DH 715 GRAPHICS 18:POSITION 5,2:? #6
      ;"SCORE ";SC
PI 720 POSITION 4,6:? #6;"PUSH JOYST
      ICK":POSITION 3,7:? #6;"TO PLA
      Y AGAIN"
KI 740 IF STRIG(0)=0 THEN SOUND 0,0,
      0,0:GOTO 170
II 750 RESTORE 110:FOR I=1 TO 35:REA
      D A:SOUND 0,A,10,8:FOR J=1 TO
      12:NEXT J:NEXT I:SOUND 0,0,0,0
```

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Alphabet Zoo (D) 20
Trains (D) $27
Delta Drawing (R) $27
Delta Music (R) $27

SUBLOGIC
Flight Simulator II (D) $36
Pinball (C/D) $22

SYNAPSE
Ft. Apocalypse (C/D) $23
Necromancer (C/D) $23
Zaxxon (D) $23
Blue Max (D) $23
Pharoah's Curse (C/D) $23
Zepplin (D) $23
Quasimodo (D) $23

SSI
Combat Leader (C/D) $27
Computer Baseball (D) $27
Eagles (D) $27
Ringside Seat (D) $27
Tigers In Snow (C/D) $27
Battle Normandy (C/D) $27

TIMEWORKS
Dungeons of Alg. (C/D) $17
Robbers Lost (C/D) $17
Money Mgr. (C/D) $17
Wall Street (C/D) $17
Data Manager (C/D) $17
Elec. Checkbook (C/D) $17

TOTL
Totl Text (C) $32 (D) $34
Label (C) $15 (D) $17
Time Mgr. (C) $24 (D) $27
Rsrch. Asst. (C) $24 (D) $27

TRONIX
S.A.M. (D) $39
Juice (D) $23
Chatterbee (D) $27

MISCELLANEOUS
Diskey (D) $33
Barrons Sat (D) $59
Millionaire (D) $39
Sargon II (D) $23
B Graph (D) $59
Castle Wollenstein (D) $20
Odesta Chess (D) $46
Ultima III (D) $39
Prof. Blackjack (D) $46
Homeword (D) $46
Pers. Accountant (D) $23
Karate Devils (D) $27
Final Flight (D) $22
MAE Assembler (D) $47

```
HB 760 GOTO 740
HF 770 END
EB 1999 REM MISSILE MOVEMENT
FL 2000 YH1=Y1
HG 2010 Y1=Y1-5
PF 2020 IF Y1<5 THEN GUN=0:SOUND 0,0
        ,0,0:RETURN
GJ 2030 POKE PMBASE+384+YH1,0:POKE P
        MBASE+384+Y1,4:SOUND 0,Y1,8,
        10
JB 2035 IF PEEK(53257)<>3THEN RETURN
AN 2040 GOSUB 2500
MA 2050 POKE 77,0
AG 2100 POKE PMBASE+384+Y1,0:GUN=0:P
        OKE 53278,1:SOUND 0,0,0,0:RE
        TURN
MG 2499 REM CHECK COLLISION
KL 2500 REM
CL 2510 XCOR=4*6*DT+45
PH 2520 IF XM1<XCOR+15 AND XM1>XCOR-
        3 THEN GOSUB 3000:HIT=1:GOTO
         2540
BD 2530 GOSUB 2700
DM 2540 GUN=0:RETURN
HI 2699 REM UFO CLUNKS
CE 2700 POKE 704,14
EO 2710 FOR I=1 TO 25:SOUND 0,150+I,
        10,8:NEXT I
PN 2720 SOUND 0,0,0,0:POKE 704,24:PO
        KE 53278,1
KM 2730 RETURN
AJ 2799 REM EXPLOSION SOUND
BF 2800 FOR I=1 TO 2:N=INT(10*RND(0)
        +1)*10
DC 2810 FOR L=15 TO 0 STEP -1:SOUND
        0,N,0,L:SOUND 1,N+1,0,L:SOUN
        D 2,N+2,0,L:SOUND 3,N/2,0,L
PH 2820 FOR J=1 TO 10:NEXT J:NEXT L
CE 2830 POKE 53258,3:NEXT I
IM 2840 POKE 53258,1:POKE 53250,250
KP 2850 RETURN
GB 2999 REM DIRECT HIT
AF 3000 POKE 53248,250:POKE 53250,X0
        :POKE 53253,250
GD 3025 POSITION 6*DT,INT((Y0-14)/4)
JK 3030 IF Y0=40 THEN SC=SC+25:SCL=S
        CL+25:? "25"
IL 3040 IF Y0=60 THEN SC=SC+10:SCL=S
        CL+10:? "10"
AK 3050 IF Y0=80 THEN SC=SC+5:SCL=SC
        L+5:? "5"
BH 3055 GOSUB 2800
GB 3060 POSITION 30,2:? " ";SC:FOR I
        =1 TO 250:NEXT I
AJ 3070 IF SCL>=50 AND SCL/PB>20 THE
        N POSITION 13,12:HU=5:? "50
        BONUS POINTS":SC=SC+50:GOTO
        3090
EJ 3080 IF SCL>=50 AND SCL/PB>=10 TH
        EN POSITION 13,12:HU=4:? "25
         BONUS POINTS":SC=SC+25:GOTO
         3090
NA 3085 GOTO 3130
EA 3090 FOR I=1 TO 3
KF 3100 SETCOLOR 2,HU,4:SOUND 0,25,1
        0,8:FOR J=1 TO 50:NEXT J
AN 3110 SETCOLOR 2,0,2:SOUND 0,75,10
        ,8:FOR J=1 TO 50:NEXT J:NEXT
        I:SOUND 0,0,0,0:SOUND 1,0,0,0
IK 3120 POSITION 30,2:? " ";SC
KH 3130 RETURN
AG 3499 REM CHANGE UFO HEIGHT
PB 3500 FOR I=PMBASE+512+Y01 TO PMBA
        SE+518+Y01:GOSUB 3600:POKE I
        ,0:NEXT I
AF 3510 FOR I=PMBASE+768+Y01 TO PMBA
        SE+776+Y01:GOSUB 3600:POKE I
        ,0:NEXT I
PE 3520 Y0=40
GI 3530 RESTORE 3535:FOR I=PMBASE+51
        2+Y0 TO PMBASE+518+Y0:GOSUB
        3600:READ A:POKE I,A:NEXT I
FO 3535 DATA 24,60,255,255,255,60,24
HN 3540 RESTORE 3545:FOR I=PMBASE+76
        8+Y0 TO PMBASE+776+Y0:GOSUB
        3600:READ A:POKE I,A:NEXT I
GF 3545 DATA 16,68,82,137,66,161,34,
        68,16
FC 3546 Y01=Y0
IJ 3550 PM1=PMBASE+512+Y0:PM2=PMBASE
        +768+Y0
JK 3560 POKE 204,INT(PM1/256):POKE 2
        07,INT(PM2/256)
OK 3570 POKE 203,PM1-(PEEK(204)*256)
        -1:POKE 206,PM2-(PEEK(207)*2
        56)-1
GB 3580 POKE 205,7:POKE 208,9
LB 3590 RETURN
BH 3600 ST=STICK(0):X1=X1+4*((ST=7)+
        (X1<210)):X1=X1-4*((ST=11)+(
        X1>40)):POKE 53249,X1
KK 3610 RETURN
DB 3699 REM UFO DOWN
KG 3700 Y0=Y0+20
GD 3710 FOR I=1 TO 20
PM 3720 AB=USR(1536):BA=USR(1551):GO
        SUB 3600:NEXT I
FB 3725 Y01=Y0
KN 3730 RETURN
LP 3999 REM VERTICAL MOVEMENT DOWN
LB 4000 RESTORE 4050
HF 4010 FOR I=1536 TO 1565
AE 4020 READ A:POKE I,A:NEXT I
KH 4030 RETURN
NI 4050 DATA 104,164,205,177,203,200
        ,145,203,136,136,16,247,230,
        203,96
OF 4060 DATA 104,164,208,177,206,200
        ,145,206,136,136,16,247,230,
        206,96
PI 4999 REM MENU
AN 5000 GRAPHICS 0:? CHR$(125):POKE
        752,1
CD 5020 POSITION 11,2:? "MISSILE MAT
        H MENU"
MM 5030 ? :? "MOVE JOYSTICK AND PUSH
         TRIGGER":? "TO SELECT GAME"
BC 5060 M$="{O}{W}{E}{DOWN}{3 LEFT}
        {A} {D}{DOWN}{3 LEFT}{Z}{X}
        {C}"
GE 5070 POSITION 8,11:? "ADDITION &
        {4 SPACES}MULTIPLICATION"
KD 5075 POSITION 8,12:? "SUBTRACTION
        {3 SPACES}& DIVISION"
EP 5080 ? :? :? "SLOW{4 SPACES}{UP}"
        ;M$
DN 5085 ? :? :? "FAST{4 SPACES}{UP}"
        ;M$
```

```
LK 5090 POSITION 25,14:? M$:POSITION
        25,18:? M$
HF 5100 SCR=PEEK(88)+256*PEEK(89):XC
        =611:MENU=1:DX=1
BN 5110 POKE SCR+XC,83:FOR DLY=1 TO
        50:NEXT DLY
OD 5120 POKE SCR+XC,0:FOR DLY=1 TO 5
        0:NEXT DLY
AB 5130 IF STRIG(0)=0 THEN GOTO 5230
LB 5135 ST=STICK(0)
OK 5140 IF ST=7 AND XC=611 THEN XC=6
        26:MENU=2
NB 5150 IF ST=13 AND XC=611 THEN XC=
        771:DX=3
NO 5160 IF ST=13 AND XC=626 THEN XC=
        786:DX=3
GH 5170 IF ST=11 AND XC=626 THEN XC=
        611:MENU=1
NO 5180 IF ST=14 AND XC=771 THEN XC=
        611:DX=1
EN 5190 IF ST=7 AND XC=771 THEN XC=7
        86:MENU=2
GP 5200 IF ST=11 AND XC=786 THEN XC=
        771:MENU=1
NJ 5210 IF ST=14 AND XC=786 THEN XC=
        626:DX=1
MJ 5220 GOTO 5110
KK 5230 RETURN
JP 5499 REM INITIALIZE PM GRAPHICS
JA 5500 X1=250:Y1=95:X0=250:Y0=40
OD 5510 J=PEEK(106)-8:POKE 54279,J:P
        MBASE=256*J
AE 5520 POKE 559,46:POKE 53277,3
LN 5530 POKE 53256,1:POKE 53257,1:PO
        KE 53258,1:POKE 53260,1
LK 5540 FOR I=PMBASE+384 TO PMBASE+8
        96:POKE I,0:NEXT I
PG 5570 RESTORE 5580:FOR I=PMBASE+64
        0+Y1 TO PMBASE+649+Y1:READ A
        :POKE I,A:NEXT I
AA 5580 DATA 8,8,8,8,8,28,127,127,54
        ,54
IC 5610 POKE 704,24:POKE 705,200:POK
        E 706,14
PH 5620 POKE 53248,X0:POKE 53249,X1:
        POKE 53250,X0
KD 5630 RETURN
```

Program 2:

VIC Missile Math, Machine Language

Refer to the "Automatic Proofreader" article before typing this program in

```
12288 :160,000,141,106,003,152,050
12294 :153,064,003,200,192,120,226
12300 :208,248,169,001,141,068,079
12306 :003,032,102,048,096,032,075
12312 :001,049,173,062,003,072,128
12318 :168,169,035,153,206,017,010
12324 :200,169,036,153,206,017,049
12330 :200,169,037,153,206,017,056
12336 :104,168,162,000,173,068,211
12342 :003,153,206,149,200,232,229
12348 :224,003,208,244,172,062,205
12354 :003,096,172,062,003,162,052
12360 :000,169,032,153,206,017,137
12366 :200,232,224,003,208,245,166
12372 :172,062,003,200,169,032,210
12378 :153,184,017,169,007,153,005
12384 :184,149,172,062,003,096,250
12390 :169,207,141,019,145,173,188
12396 :017,145,141,070,003,169,141
12402 :127,141,034,145,173,032,254
12408 :145,073,255,041,128,013,007
12414 :070,003,041,176,141,074,119
12420 :003,169,255,141,034,145,111
12426 :173,074,003,201,048,240,109
12432 :054,201,016,208,019,173,047
12438 :112,003,205,100,003,240,045
12444 :005,169,001,141,092,003,055
12450 :173,100,003,141,112,003,182
12456 :173,074,003,201,032,208,091
12462 :010,172,078,003,192,000,117
12468 :240,003,206,078,003,201,143
12474 :176,208,010,172,078,003,065
12480 :192,003,176,003,238,078,114
12486 :003,172,078,003,185,252,123
12492 :048,141,062,003,072,152,170
12498 :072,032,023,048,104,168,145
12504 :104,172,078,003,204,066,075
12510 :003,240,012,172,066,003,206
12516 :185,252,048,141,062,003,151
12522 :032,068,048,172,078,003,123
12528 :140,066,003,173,092,003,205
12534 :240,003,032,065,049,096,219
12540 :003,007,011,015,019,024,075
12546 :173,062,003,105,206,133,172
12552 :253,169,017,105,000,133,173
12558 :254,056,165,253,233,021,228
12564 :133,253,165,254,233,000,034
12570 :133,254,024,165,253,105,192
12576 :000,133,253,165,254,105,174
12582 :132,133,254,169,002,160,120
12588 :000,145,253,056,165,253,148
12594 :233,000,133,253,165,254,064
12600 :233,132,133,254,169,038,247
12606 :145,253,096,169,022,141,120
12612 :104,003,162,005,160,021,011
12618 :189,021,050,133,163,189,051
12624 :253,049,133,164,202,189,046
12630 :021,050,133,168,189,253,132
12636 :049,133,169,032,212,050,225
12642 :177,163,201,038,144,061,114
12648 :201,040,176,057,072,177,059
12654 :168,201,057,144,013,104,029
12660 :140,110,003,032,203,049,141
12666 :172,110,003,076,129,049,149
12672 :104,145,168,024,165,168,134
12678 :105,000,133,168,165,169,106
12684 :105,132,133,169,169,002,082
12690 :145,168,056,165,168,233,057
12696 :000,133,168,165,169,233,252
12702 :132,133,169,169,032,145,170
12708 :163,136,016,183,232,232,102
12714 :224,023,208,154,206,104,065
12720 :003,173,104,003,016,144,107
12726 :169,032,141,092,016,141,005
12732 :096,016,141,100,016,141,186
12738 :104,016,136,169,000,141,248
12744 :092,003,096,072,173,133,001
12750 :003,205,078,003,208,015,206
12756 :032,228,050,104,169,000,027
12762 :072,169,003,141,132,003,226
12768 :076,231,049,104,177,168,005
12774 :072,104,096,024,169,206,133
12780 :109,062,003,133,253,169,197
12786 :017,105,000,133,254,169,152
12792 :000,141,065,049,096,016,103
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12798 :016,016,016,016,016,016,094
12804 :016,016,016,016,016,017,101
12810 :017,017,017,017,017,017,112
12816 :017,017,017,017,017,000,101
12822 :022,044,066,088,110,132,228
12828 :154,176,198,220,242,008,002
12834 :030,052,074,096,118,140,032
12840 :162,184,206,228,250,173,219
12846 :106,003,208,029,169,110,159
12852 :133,251,169,016,133,252,238
12858 :160,019,140,096,003,169,133
12864 :005,141,098,003,169,001,225
12870 :141,106,003,169,000,141,118
12876 :100,003,096,173,100,003,039
12882 :201,003,144,013,169,000,100
12888 :141,106,003,169,002,141,138
12894 :132,003,076,211,050,172,226
12900 :096,003,169,058,145,251,054
12906 :200,169,060,145,251,200,107
12912 :169,062,145,251,172,096,239
12918 :003,200,200,200,169,032,154
12924 :145,251,200,145,251,200,036
12930 :145,251,172,096,003,024,053
12936 :165,251,105,000,133,251,017
12942 :165,252,105,132,133,252,157
12948 :173,098,003,145,251,200,250
12954 :145,251,200,145,251,056,178
12960 :165,251,233,000,133,251,169
12966 :165,252,233,132,133,252,053
12972 :206,096,003,173,096,003,237
12978 :208,031,169,032,145,251,246
12984 :136,145,251,136,145,251,224
12990 :024,165,251,105,132,133,232
12996 :251,165,252,105,000,133,078
13002 :252,160,019,140,096,003,104
13008 :238,100,003,096,072,152,101
13014 :072,138,072,160,050,136,074
13020 :208,253,104,170,104,168,203
13026 :104,096,169,015,141,014,253
13032 :144,169,128,141,013,144,203
13038 :162,255,032,212,050,202,127
13044 :208,250,169,000,141,014,002
13050 :144,169,032,145,168,172,056
13056 :096,003,200,169,000,145,101
13062 :251,200,169,000,145,251,254
13068 :200,169,000,145,251,024,033
13074 :165,251,105,000,133,251,155
13080 :165,252,105,132,133,252,039
13086 :172,096,003,200,145,251,129
13092 :200,145,251,200,145,251,204
13098 :056,165,251,233,000,133,112
13104 :251,165,252,233,132,133,190
13110 :252,162,255,032,212,050,249
13116 :202,208,250,202,208,253,103
13122 :096,160,000,185,000,128,123
13128 :153,000,020,200,208,247,132
13134 :160,000,185,000,129,153,193
13140 :000,021,200,208,247,160,152
13146 :000,185,000,130,153,000,046
13152 :022,200,208,247,160,000,165
13158 :185,000,131,153,000,023,082
13164 :200,208,247,160,007,185,091
13170 :172,051,153,000,020,136,134
13176 :016,247,160,031,185,180,171
13182 :051,153,024,021,136,016,015
13188 :247,160,007,185,212,051,226
13194 :153,208,021,136,016,247,151
13200 :160,007,185,220,051,153,152
13206 :224,021,136,016,247,160,186
13212 :007,185,228,051,153,240,252
13218 :021,136,016,247,169,205,188
13224 :141,005,144,096,146,073,005
13230 :164,073,018,164,146,000,227
13236 :000,000,001,003,031,063,022
13242 :112,240,024,255,255,255,047
13248 :255,255,000,000,000,000,190
13254 :128,192,248,252,014,015,023
13260 :000,033,030,030,030,033,104
13266 :000,000,000,000,000,007,217
13272 :031,063,127,127,000,000,052
13278 :000,255,255,255,255,255,217
13284 :001,007,031,255,255,255,008
13290 :255,255,013,013,013,013,028
```

Program 3: VIC Missile Math, BASIC

Refer to the "Automatic Proofreader" article before typing this program in.

```
5 POKE 36879,8:POKE56,48:CLR:SYS65017
                                        :rem 156
10 PRINT"{CLR}{2 DOWN}{WHT}":A$="MISSILE
   {SPACE}MATH":GOSUB900                :rem 159
15 POKE36869,192                        :rem 109
20 PRINT"{3 DOWN}{5 RIGHT}{RED}DO YOU WAN
   T TO:"                               :rem 186
30 PRINT"{2 DOWN}{RIGHT}{CYN}ADD&
   {7 SPACES}{WHT}MULTIPLY"             :rem 134
40 PRINT"{CYN}{DOWN}{RIGHT}SUBTRACT
   {3 SPACES}{WHT}& DIVIDE"             :rem 74
50 PRINT"{2 DOWN}{GRN}SLOW":PRINT"
   {2 DOWN}{CYN}FAST{YEL}":G=15:H=5
                                        :rem 107
55 H=5 :G=15:GF=20                      :rem 174
60 V1=37139:REM DDR FOR SWITCH UPDNLFTFIR
   E                                    :rem 37
61 R1 =37137:REM PORTAB2=UP;B3=DN;B4=LFT:
   B5=FIRE                              :rem 141
62 V2=37154:REM DDR FOR RIGHT           :rem 142
63 R2= 37152:REM PORTB;B7= RIGHT        :rem 64
64 POKE37139,195:J1=PEEK(37137):POKE37139
   ,128                                 :rem 15
65 POKE37154,127:J2=PEEK(37152)AND128:POK
   E37154,255                           :rem 114
66 B=J1ORJ2                             :rem 131
70 IF B= 156THEN 90                     :rem 169
80 IFB=172THENH=5                       :rem 249
81 IFB=60THENH=14                       :rem 246
82 IFB=184THENG=15:GF=20                :rem 148
83 IFB=180THENG=18:GF=10                :rem 147
84 POKE781,G:POKE782,H:POKE783,0:SYS65520
   :PRINT"Q"                            :rem 170
85 IF OG<>G OR OH<>H THENPOKE781,OG:POKE7
   82,OH:POKE783,0:SYS65520:PRINT" "
                                        :rem 135
86 OG=G:OH=H:GOTO60                     :rem 183
90 L=1:SC=0:S=3                         :rem 93
100 PRINT"{CLR}{3 DOWN}{2 RIGHT}{WHT}POSI
    TION GUN OVER{7 SPACES}CORRECT ANSWER
    "                                   :rem 228
105 BN=0:BO=0:B=0:SH=0:SYS13123         :rem 41
110 PRINT"{4 DOWN}{4 RIGHT}AND SHOOT UFO"
                                        :rem 101
120 PRINT"{3 DOWN}{4 RIGHT}{WHT}BE CAREFU
    L NOT{8 SPACES}TO WASTE SHOTS":rem 66
130 PRINT"{2 DOWN}{3 RIGHT}{CYN}ENTERING
    {SPACE}LEVEL";L                     :rem 216
135 GOSUB 1000                          :rem 218
140 FORI=1TO5000:NEXT                   :rem 20
141 PRINT"{CLR}{11 SPACES}{WHT}SCORE{RED}
    "SC"{HOME}{BLU}";                   :rem 222
```

```
142 FORI=1TOS:PRINT"{RIGHT}A";:NEXT
                                    :rem 200
150 A=INT(RND(0)*4+1)+4*(L-1)       :rem 243
160 B=INT(RND(0)*4*L+1)             :rem 231
170 IFH=5THENC=A+B:GOTO180           :rem 74
175 C=A*B                           :rem 202
180 A$=STR$(A):B$=STR$(B):C$=STR$(C)
                                     :rem 6
190 RP=INT(RND(0)*4)+1              :rem 212
200 IFRP=1THENANS=A:A$=" ?"          :rem 31
210 IFRP=2THENANS=B:B$=" ?"          :rem 35
220 IFRP>2THENANS=C:C$=" ?"          :rem 39
230 PRINT"{HOME}{2 DOWN}{4 RIGHT}";:IFH=5
    THENPRINTA$" +"B$" ="C$:GOTO250
                                    :rem 181
240 PRINTA$" X"B$" ="C$             :rem 114
250 IFANS>90THENDEL=10:GOTO270       :rem 93
260 IFANS>20THENDEL=5:GOTO270        :rem 43
265 DEL=INT((ANS/10)+1)              :rem 10
270 DT=INT(RND(0)*4)+1              :rem 201
275 PRINT"{HOME}{21 DOWN}"          :rem 231
277 SYS12288                        :rem 164
280 FORI=1TO4:CH(I)=ANS+(I-DT)*DEL:PRINTT
    AB((I*4)-2)STR$(CH(I));"{2 LEFT}";:NE
    XT                               :rem 92
285 FORI=1TO4:IFCH(I)=ANSTHENPOKE901,I-1
                                    :rem 236
2B6 NEXT:POKE880,255                :rem 176
290 W=PEEK(868):SYS 12307:FORQ=1TOGF*10:N
    EXT:IF PEEK(900)THEN300          :rem 47
293 SYS12845                        :rem 161
295 GOTO 290                        :rem 116
300 X=PEEK(900):SH=SH+1              :rem 64
310 IFX=3THEN500                    :rem 175
320 IFX=2THEN600                    :rem 176
500 IFW=0THENB=25                   :rem 253
510 IFW=1THENB=10                   :rem 249
520 IFW=2THENB=5                    :rem 207
525 BN=BN+B                         :rem 102
526 SC=SC+B:PRINT"{HOME}{8 DOWN}
    {10 RIGHT}"B                    :rem 125
530 IFBN>=50THENL=L+1:GOTO700         :rem 1
550 GOTO 140                        :rem 104
600 S=S-1:IFS=0THEN800               :rem 39
601 PRINT"{HOME}{BLU}{8 DOWN}":A$="KEEP T
    RYING":GOSUB 900                :rem 151
602 PRINT"{2 DOWN}":A$="I KNOW YOU CAN DO
     IT":GOSUB 900                  :rem 133
603 PRINT"{2 DOWN}":A$="THE ANSWER WAS":G
    OSUB900:PRINT"{PUR}{DOWN}":A$=STR$(AN
    S):GOSUB900                     :rem 210
610 FORI=1TO1000:NEXT:GOTO140        :rem 26
700 BO=INT(BN/SH+.5)                :rem 137
710 IFBO>=25THENBO=50:GOTO750        :rem 11
720 IFBO>=10THENBO=25:GOTO750         :rem 8
730 GOTO 760                        :rem 112
750 PRINT"{HOME}{14 DOWN}{5 RIGHT}B{CYN}O
    {GRN}N{YEL}U{BLU}S"BO:SC=SC+BO
                                    :rem 240
760 FORI=1TO5000:NEXT:GOTO 100       :rem 32
800 PRINT"{CLR}{3 DOWN}{6 RIGHT}{CYN}SCOR
    E ";SC                          :rem 201
805 PRINT"{3 DOWN}{6 RIGHT}{BLU}GAME OVER
    "                               :rem 196
820 PRINT"{5 DOWN}{4 RIGHT}{CYN}PRESS ANY
     KEY {DOWN}{8 SPACES}TO PLAY AGAIN"
                                    :rem 123
830 POKE198,0                       :rem 200
835 WAIT 198,1                      :rem 212
840 GOTO5                            :rem 10
900 X=LEN(A$):A$=A$+"{2 SPACES}"    :rem 115
910 FORI=1TOX+10-INT(X/2+.5):POKE211,21-I
    :PRINTMID$(A$,1,I);             :rem 249
915 FOR T=1TO60:NEXTT:NEXTI         :rem 224
920 RETURN                          :rem 123
999 END                             :rem 130
1000 POKE3687B,15:S2=36B76:POKE36877,127
                                    :rem 218
1005 RESTORE                        :rem 234
1010 READ P,LE                      :rem 235
1020 IF P=-5THENPOKES2,0:RETURN     :rem 154
1025 POKES2,P                       :rem 248
1030 FOR T= 1 TO LE*2:NEXT          :rem 11B
1040 GOTO1010                       :rem 192
1050 DATA 173,50,127,50,173,50,192,200,12
     7,100,192,200,127,100          :rem 205
1060 DATA 192,200,192,50,189,50,1B1,50,17
     3,100,173,50,192,300,-5,-5     :rem 201
```

Programmer's Notes: VIC Version

The VIC-20 version of "Missile Math" requires at least an 8K expander. To make it easier to enter this version, the machine language portion of the program has been listed in MLX format. To enter Missile Math, you must enter Program 2 using the VIC MLX Program elsewhere in this issue. The starting address is 12288 and the ending address is 13295. After you have entered and saved Program 2, enter Program 3 as you would a normal BASIC program and save it to tape or disk.

To run Missile Math, you must first enter these POKEs.

POKE 43,1:POKE 44,24:POKE 641,0:POKE 642,24:POKE 6144,0

Type NEW and load Program 2, bypassing the normal relocator by adding ,1 to the LOAD command. Here's how your LOAD command should look:

From tape:

LOAD *"filename"* ,1,1

From disk:

LOAD *"filename"* ,8,1

Now type NEW, then load and run Program 3.

Program 4: 64 Missile Math

Refer to the "Automatic Proofreader" article before typing this program in.

```
0 GOSUB 1000                        :rem 113
1 V=54272:FORI=0TO24:POKEV+I,0:NEXT
                                    :rem 176
5 POKE 53280,0:POKE 532B1,0         :rem 13B
10 PRINT"{CLR}{4 DOWN}{BLU}":A$="MISSILE
   {SPACE}MATH":GOSUB900:GOSUB 950:rem 51
15 PRINT"{DOWN}{9 RIGHT}USE JOYSTICK IN P
   ORT #2"                          :rem 219
20 PRINT"{3 DOWN}{13 RIGHT}{RED}PLEASE SE
```

```
   LECT:"                                :rem 175
30 PRINT"{2 DOWN}{5 RIGHT}{CYN}ADDITION &
   {7 SPACES}{7}MULTIPLICATION"  :rem 192
40 PRINT"{5 RIGHT}{CYN}SUBTRACTION
   {9 SPACES}{7}& DIVISION"      :rem 216
50 PRINT"{2 DOWN}{GRN}SLOW":PRINT"
   {2 DOWN}{6}FAST{YEL}":G=18:H=9:POKE830
   ,H:POKE831,G                   :rem 92
60 X=PEEK(56320):J=XAND15:B=XAND16:rem 14
70 IFB=0THEN90                    :rem 61
80 IFJ=11THENH=9                  :rem 205
81 IFJ=7THENH=29                  :rem 213
82 IFJ=14THENG=18                   :rem 1
83 IFJ=13THENG=21                 :rem 251
84 POKE828,H:POKE829,G:SYS49152   :rem 110
85 GOTO60                         :rem 12
90 L=1:SC=0:S=3                   :rem 93
100 POKE 53269,0:PRINT"{CLR}{B DOWN}
    {4 RIGHT}{B}POSITION GUN OVER CORRECT
     ANSWER"                      :rem 215
105 BN=0:BO=0:B=0:SH=0            :rem 246
110 PRINT"{2 DOWN}{14 RIGHT}AND SHOOT UFO
    "                             :rem 101
120 PRINT"{3 DOWN}{5 RIGHT}{3}BE CAREFUL
    {SPACE}NOT TO WASTE SHOTS"    :rem 240
130 PRINT"{2 DOWN}{12 RIGHT}{PUR}ENTERING
     LEVEL";L                     :rem 21B
135 GOSUB 950                     :rem 183
140 FORI=1TO3000:NEXT             :rem 18
141 PRINT"{CLR}{30 SPACES}{GRN}SCORE{RED}
    "SC"{HOME}{BLU}";             :rem 247
142 FORI=1TOS:PRINT"{RIGHT}A";:NEXT
                                  :rem 200
150 A=INT(RND(0)*4+1)+4*(L-1)     :rem 243
160 B=INT(RND(0)*4*L+1)           :rem 231
170 IFH=9THENC=A+B:GOTO180          :rem 78
175 C=A*B                         :rem 202
180 A$=STR$(A):B$=STR$(B):C$=STR$(C)
                                    :rem 6
190 RP=INT(RND(0)*4)+1            :rem 212
200 IFRP=1THENANS=A:A$=" ?"         :rem 31
210 IFRP=2THENANS=B:B$=" ?"         :rem 35
220 IFRP>2THENANS=C:C$=" ?"         :rem 39
230 PRINT"{HOME}{4 DOWN}{15 RIGHT}{PUR}";
    :IFH=9THENPRINTA$" +"B$" ="C$:GOTO250
                                  :rem 182
240 PRINTA$" X"B$" ="C$           :rem 114
250 IFANS>90THENDEL=10:GOTO270      :rem 93
260 IFANS>20THENDEL=5:GOTO270       :rem 43
265 DEL=INT((ANS/10)+1)             :rem 10
270 DT=INT(RND(0)*5)+1            :rem 202
275 PRINT"{HOME}{21 DOWN}{YEL}"   :rem 133
280 FORI=1TO5:CH(I)=ANS+(I-DT)*DEL:PRINTT
    AB(I*5)CH(I);:NEXT            :rem 135
285 FORI=1TO5:IFCH(I)=ANSTHENPOKE901,I-1
                                  :rem 237
286 NEXT                          :rem 223
290 SYS49195                      :rem 166
300 X=PEEK(900):SH=SH+1             :rem 64
310 IFX=2THEN500                  :rem 174
320 IFX=1THEN600                  :rem 175
500 W=PEEK(833):IFW=0THENB=25     :rem 223
510 IFW=1THENB=10                 :rem 249
520 IFW=2THENB=5                  :rem 207
525 BN=BN+B                       :rem 102
526 SC=SC+B:PRINT"{HOME}{1B DOWN}
    {17 RIGHT}{GRN}"B               :rem 16
530 IFBN>=50THENL=L+1:GOTO700       :rem 1
550 GOTO 140                      :rem 104
600 S=S-1                         :rem 215
601 PRINT"{HOME}{7}{9 DOWN}":A$="KEEP TRY
    ING":GOSUB 900                :rem 35
602 PRINT"{3 DOWN}":A$="I KNOW YOU CAN DO
     IT":GOSUB 900                :rem 150
603 PRINT"{2 DOWN}":A$="THE ANSWER WAS:":
    GOSUB900:PRINT"{PUR}":A$=STR$(ANS):GO
    SUB900                        :rem 251
610 GOSUB950:IFS=0THEN800           :rem 5
620 GOTO140                       :rem 102
700 BO=INT(BN/SH+.5)              :rem 137
710 IFBO>=25THENBO=50:GOTO750       :rem 11
720 IFBO>=10THENBO=25:GOTO750       :rem 8
730 GOTO 760                      :rem 112
750 PRINT"{HOME}{14 DOWN}{14 RIGHT}{3}B
    {CYN}O{GRN}N{YEL}U{BLU}S{RED}:{WHT}"B
    O:SC=SC+BO                    :rem 230
760 FORI=1TO5000:NEXT:GOTO 100    :rem 32
800 POKE53269,0:PRINT"{CLR}{3 DOWN}
    {15 RIGHT}{CYN}SCORE:{PUR}";SC
                                  :rem 114
805 PRINT"{7 DOWN}{18 RIGHT}{BLU}GAME"
                                  :rem 40
810 PRINT"{3 DOWN}{18 RIGHT}OVER":rem 227
820 PRINT"{5 DOWN}{6 RIGHT}{GRN}PRESS
    {YEL}ANY KEY{GRN} TO PLAY AGAIN"
                                  :rem 223
830 POKE198,0                     :rem 200
835 WAIT 198,1                    :rem 212
840 GOTO5                           :rem 10
900 X=LEN(A$):A$=A$+"{24 SPACES}":rem 115
910 FORI=1TOX+19-INT(X/2+.5):POKE211,39-I
    :PRINTMID$(A$,1,I);:NEXT I    :rem 205
920 RETURN                        :rem 123
950 V=54272:POKEV+24,15:POKEV+5,0:POKEV+6
    ,240                          :rem 116
955 POKEV+1,25:POKEV,30:POKEV+4,33:FORI=1
    TO300:NEXT:POKEV+4,32           :rem 75
960 POKEV+1,33:POKEV,135:POKEV+4,33:FORI=
    1TO900:NEXT:POKEV+4,32        :rem 130
970 POKEV+1,25:POKEV,30:POKEV+4,33:FORI=1
    TO400:NEXT:POKEV+4,32           :rem 73
980 POKEV+1,33:POKEV,135:POKEV+4,33:FORI=
    1TO100:NEXT:POKEV+4,32        :rem 124
990 POKEV+1,29:POKEV,223:POKEV+4,33:FORI=
    1TO100:NEXT:POKEV+4,32        :rem 128
992 POKEV+1,28:POKEV,49:POKEV+4,33:FORI=1
    TO100:NEXT:POKEV+4,32           :rem 87
994 POKEV+1,25:POKEV,30:POKEV+4,33:FORI=1
    TO700:NEXT:POKEV+4,32           :rem 82
996 FORI=1TO100:NEXT              :rem 243
998 POKEV+1,25:POKEV,30:POKEV+4,33:FORI=1
    TO360:NEXT:POKEV+4,32           :rem 88
999 POKEV+1,33:POKEV,135:POKEV+4,33:FORI=
    1TO600:NEXT:POKEV+4,32:RETURN:rem 165
1000 PRINT"{CLR}{10 DOWN}{8 RIGHT}LOADING
      MACHINE LANGUAGE":I=49152:CK=0
                                  :rem 232
1010 READ A:IF A=256 THEN 1030    :rem 246
1020 POKE I,A:CK=CK+A:I=I+1:GOTO 1010
                                  :rem 65
1030 IFCK<>80338THENPRINT"ERROR IN DATA":
     STOP                         :rem 28
1040 RETURN                       :rem 165
1050 DATA 174,63,3,172,62,3         :rem 41
1060 DATA 24,32,240,255,169,32    :rem 191
1070 DATA 32,210,255,174,61,3     :rem 136
10B0 DATA 172,60,3,24,32,240        :rem B3
1090 DATA 255,169,209,32,210,255  :rem 43
1100 DATA 173,61,3,141,63,3         :rem 31
1110 DATA 173,60,3,141,62,3         :rem 30
```

Notes On The Commodore 64, TI, Apple, And IBM PC/PCjr Versions

Instructions for all these versions are included within the programs themselves. The 64 version (Program 4) requires a joystick in port 2. The TI-99/4A version (Program 5) requires Extended BASIC and may be played with either a joystick or the keyboard. The Apple version (Program 6) requires a paddle controller. The IBM PC/PCjr version (Program 7) is controlled from the keyboard.

```
1120 DATA 96,32,106,194,169,2     :rem 149
1130 DATA 141,64,3,169,0,141       :rem 84
1140 DATA 65,3,169,1,141,66        :rem 45
1150 DATA 3,169,100,141,67,3       :rem 87
1160 DATA 169,250,141,248,7,169     :rem 0
1170 DATA 251,141,249,7,169,252   :rem 252
1180 DATA 141,250,7,169,7,141     :rem 145
1190 DATA 21,208,169,6,141,39     :rem 150
1200 DATA 208,169,8,141,40,208    :rem 191
1210 DATA 169,15,141,41,208,169   :rem 245
1220 DATA 0,141,23,208,169,2       :rem 82
1230 DATA 141,29,208,169,255,141   :rem 41
1240 DATA 27,208,141,68,3,169     :rem 151
1250 DATA 0,141,70,3,173,30        :rem 28
1260 DATA 208,169,0,162,24,157    :rem 197
1270 DATA 0,212,202,224,255,208   :rem 231
1280 DATA 248,169,15,141,24,212   :rem 246
1290 DATA 173,61,3,201,21,208     :rem 135
1300 DATA 8,169,15,141,77,3        :rem 47
1310 DATA 76,164,192,169,22,141   :rem 249
1320 DATA 77,3,32,227,192,32       :rem 94
1330 DATA 54,193,32,160,193,32    :rem 193
1340 DATA 230,193,32,218,193,173   :rem 40
1350 DATA 68,3,208,236,169,17     :rem 157
1360 DATA 141,5,212,141,6,212     :rem 129
1370 DATA 169,129,141,4,212,169   :rem 252
1380 DATA 1,141,1,212,169,30       :rem 82
1390 DATA 141,76,3,32,218,193     :rem 150
1400 DATA 206,76,3,208,248,169    :rem 203
1410 DATA 0,170,157,0,212,232     :rem 125
1420 DATA 224,25,208,248,96,174   :rem 255
1430 DATA 64,3,189,82,194,141     :rem 155
1440 DATA 0,208,169,200,141,1     :rem 130
1450 DATA 208,173,67,3,141,2       :rem 93
1460 DATA 208,173,66,3,10,141     :rem 140
1470 DATA 16,208,174,65,3,189     :rem 159
1480 DATA 102,194,141,3,208,173   :rem 242
1490 DATA 70,3,201,1,240,14        :rem 29
1500 DATA 174,64,3,189,82,194     :rem 159
1510 DATA 141,4,208,169,200,141   :rem 233
1520 DATA 5,208,173,76,3,240       :rem 94
1530 DATA 20,206,76,3,173,76       :rem 97
1540 DATA 3,10,10,141,1,212        :rem 17
1550 DATA 201,0,208,5,169,128     :rem 142
1560 DATA 141,4,212,96,173,67     :rem 152
1570 DATA 3,208,3,206,66,3        :rem 250
1580 DATA 206,67,3,173,66,3        :rem 54
1590 DATA 24,109,67,3,201,0        :rem 40
1600 DATA 208,23,238,65,3,169     :rem 151
1610 DATA 1,141,66,3,169,80        :rem 44
1620 DATA 141,67,3,169,0,141       :rem 91
1630 DATA 70,3,169,8,141,40        :rem 44
1640 DATA 208,173,0,220,141,69    :rem 191
1650 DATA 3,41,8,240,18,173        :rem 44
1660 DATA 69,3,41,4,208,21        :rem 251
1670 DATA 173,64,3,240,16,206     :rem 145
1680 DATA 64,3,76,137,193,173     :rem 162
1690 DATA 64,3,201,16,240,3        :rem 38
1700 DATA 238,64,3,173,70,3        :rem 45
1710 DATA 201,1,208,15,206,5       :rem 80
1720 DATA 208,173,5,208,201,30    :rem 186
1730 DATA 208,5,169,2,141,70       :rem 95
1740 DATA 3,96,173,69,3,41          :rem 6
1750 DATA 16,201,0,208,36,173     :rem 139
1760 DATA 70,3,208,31,169,1        :rem 45
1770 DATA 141,70,3,173,64,3        :rem 45
1780 DATA 74,74,141,71,3,169      :rem 109
1790 DATA 17,141,5,212,141,6       :rem 91
1800 DATA 212,169,129,141,4,212   :rem 239
1810 DATA 169,10,141,76,3,173     :rem 146
1820 DATA 70,3,201,1,240,5        :rem 234
1830 DATA 169,5,141,71,3,96        :rem 55
1840 DATA 174,77,3,160,0,136       :rem 97
1850 DATA 208,253,202,208,250,96   :rem 44
1860 DATA 173,30,208,141,72,3     :rem 143
1870 DATA 41,1,141,73,3,173        :rem 42
1880 DATA 72,3,41,2,74,141        :rem 251
1890 DATA 74,3,173,72,3,41          :rem 2
1900 DATA 4,74,74,141,75,3        :rem 255
1910 DATA 173,73,3,45,74,3          :rem 0
1920 DATA 201,1,208,3,76,31        :rem 36
1930 DATA 194,173,74,3,45,75      :rem 111
1940 DATA 3,201,1,208,3,76        :rem 245
1950 DATA 52,194,96,169,253,141     :rem 9
1960 DATA 248,7,169,1,141,21      :rem 101
1970 DATA 208,169,1,141,132,3     :rem 145
1980 DATA 169,0,141,68,3,96        :rem 62
1990 DATA 173,133,3,205,71,3       :rem 96
2000 DATA 208,16,169,253,141,249   :rem 40
2010 DATA 7,169,2,141,132,3        :rem 33
2020 DATA 169,0,141,68,3,96        :rem 48
2030 DATA 169,1,141,40,208,96     :rem 143
2040 DATA 70,70,70,70,110,110     :rem 124
2050 DATA 110,110,150,150,150,150 :rem 57
2060 DATA 190,190,190,190,230,230 :rem 80
2070 DATA 230,230,100,133,167,200 :rem 65
2080 DATA 162,0,189,118,194,157     :rem 0
2090 DATA 128,62,232,208,247,96     :rem 1
2100 DATA 0,0,0,0,0,0             :rem 217
2110 DATA 0,24,0,0,24,0            :rem 70
2120 DATA 0,24,0,0,24,0            :rem 71
2130 DATA 0,24,0,0,24,0            :rem 72
2140 DATA 0,24,0,0,24,0            :rem 73
2150 DATA 0,60,0,0,60,0            :rem 74
2160 DATA 0,60,0,0,60,0            :rem 75
2170 DATA 1,255,128,15,255,240    :rem 192
2180 DATA 127,255,254,127,0,254   :rem 247
2190 DATA 112,0,14,96,0,6         :rem 192
2200 DATA 96,0,6,192,0,0          :rem 139
2210 DATA 0,0,0,0,0,0             :rem 219
2220 DATA 0,0,0,0,0,0             :rem 220
2230 DATA 0,0,255,0,1,255         :rem 182
2240 DATA 128,7,255,224,31,255    :rem 196
2250 DATA 248,255,255,255,255,255:rem 105
2260 DATA 255,255,255,255,255,255:rem 104
2270 DATA 255,31,255,248,7,255    :rem 206
2280 DATA 224,1,255,128,0,255     :rem 142
2290 DATA 0,0,0,0,0,0             :rem 227
2300 DATA 0,0,0,0,0,0             :rem 219
2310 DATA 0,164,0,24,0,0          :rem 125
```

```
2320 DATA 24,0,0,0,0,0              :rem 19
2330 DATA 0,0,0,0,0,0               :rem 222
2340 DATA 0,0,0,0,0,0               :rem 223
2350 DATA 0,0,0,0,0,0               :rem 224
2360 DATA 0,0,0,0,0,0               :rem 225
2370 DATA 0,0,0,0,0,0               :rem 226
2380 DATA 0,0,0,0,0,0               :rem 227
2390 DATA 0,0,0,0,0,0               :rem 228
2400 DATA 0,0,0,0,0,0               :rem 220
2410 DATA 0,0,0,0,0,247             :rem 74
2420 DATA 0,0,0,0,32,0              :rem 19
2430 DATA 40,128,64,0,136,0         :rem 34
2440 DATA 2,2,0,130,33,128          :rem 233
2450 DATA 2,18,196,16,168,0         :rem 50
2460 DATA 17,11,0,1,169,0           :rem 189
2470 DATA 1,45,72,17,146,8          :rem 1
2480 DATA 0,136,144,0,8,8           :rem 199
2490 DATA 8,120,0,2,24,128          :rem 243
2500 DATA 16,8,16,0,0,32            :rem 136
2510 DATA 2,3,0,1,32,0              :rem 25
2520 DATA 0,0,0,193,256             :rem 93
```

Program 5: TI-99/4A Missile Math

```
90 REM EXTENDED BASIC REQUIRED
100 DIM NOTE(14),DUR(14):: GOSUB 990 :: GOTO 150
110 CALL KEY(0,K,ST):: CALL KEY(1,KK,S):: IF ST=0 THEN CALL JOYST(1,X,Y)ELSE X=(K=83)-(K=68):: Y=(K=69)-(K=88)
120 RETURN
130 FOR I=1 TO L :: B$=SEG$(E$,1,I) :: DISPLAY AT(Y,X-I):B$ :: CALL SOUND(-10,-6,4)::NEXT I ::RETURN
140 FOR I=1 TO 14 :: CALL SOUND(DUR(I),NOTE(I),3):: NEXT I :: RETURN
150 E$="MISSILE MATH"
160 CALL CLEAR
170 CALL SCREEN(5)
180 Y=12 :: X=25 :: L=16 :: GOSUB 130 :: FOR T=1 TO 100 :: NEXT T
190 GOSUB 140 :: FOR T=1 TO 300 :: NEXT T
200 FOR I=16 TO 24 :: DISPLAY AT(12,25-I):B$ :: NEXT I :: FOR I=2 TO 13 :: B$=SEG$(E$,I,12):: DISPLAY AT(12,1):B$ :: NEXT I
210 GOSUB 840
220 CALL CLEAR :: CALL SCREEN(3):: PRINT "TO PLAY:": : :: PRINT "POSITION GUN OVER CORRECT": : :: PRINT "ANSWER AND SHOOT THE UFO": :
230 PRINT "WITH FIREBUTTON OR SPACE BAR.": : : : :: PRINT "BE CAREFUL NOT TO WASTE": : :: PRINT "SHOTS.": : : :
240 PRINT "FIRE OR <ENTER> TO START.": : : :
250 GOSUB 110 :: IF (KK<>18)*(K<>13)THEN 250
260 LEVEL=1 :: SC,HIT,GUN=0 :: NP=3 :: PT(1)=25 :: PT(2)=10 :: PT(3)=5 :: SPR=136
270 CALL CLEAR :: CALL SCREEN(11):: DISPLAY AT(12,7):"ENTERING LEVEL";LEVEL :: GOSUB 140 :: FOR T=1 TO 100 :: NEXT T
280 PB,SCL=0
290 RANDOMIZE :: Y0=4 :: PF=5 :: A=INT(RND*4+1)+4*(LEVEL-1):: B=INT(RND*4*LEVEL+ 1)
300 IF MENU=1 THEN C=A+B ELSE C=A*B
310 A$=STR$(A):: B$=STR$(B):: C$=STR$(C)
320 RANDOMIZE :: RP=INT(RND*4)+1
330 IF RP=1 THEN ANS=A :: A$=CHR$(63)
340 IF RP=2 THEN ANS=B :: B$=CHR$(63)
350 IF (RP=3)+(RP=4)THEN ANS=C :: C$=CHR$(63)
360 CALL CLEAR :: CALL SCREEN(15)
370 D$=" + " :: IF MENU=2 THEN D$=" z "
380 DISPLAY AT(4,10):A$;D$;B$;" = ";C$
390 FOR I=1 TO NP :: CALL HCHAR(1,I*2+1,112):: NEXT I
400 DISPLAY AT(1,17):"SCORE:";SC :: PB=PB+1
410 IF ANS>90 THEN DEL=10 :: GOTO 440
420 IF ANS>20 THEN DEL=5 :: GOTO 440
430 DEL=INT((ANS/10)+1)
440 RANDOMIZE :: DT=INT(RND*5)+1
450 X1=256 :: X2=1
460 FOR I=1 TO 5 :: CH(I)=ANS+(I-DT)*DEL :: LOK(I)=5*I-1 :: DISPLAY AT(24,LOK(I)):STR$(CH(I));:: NEXT I
470 CALL SPRITE(#2,96,6,150,LOK(PF)*B+4)
480 SHT=0 :: SP=14 :: FOR X0=X1 TO X2 STEP -DX :: CALL SPRITE(#1,128,SP,Y0*B,X0):: SP=24-SP
490 CALL SOUND(-10,2000,3):: GOSUB 110 :: PF=PF+SGN(X):: PF=PF+(PF=6)*5-(PF=0)*5 :: CALL LOCATE(#2,150,LOK(PF)*B+4):: GOSUB 110
500 IF ((KK=18)+(K=32))*(SHT=0)THEN CALL SPRITE(#3,124,2,150,LOK(PF)*B+4,-20,0):: CALL SOUND(200,-6,3):: GUN=1 :: SHT=1
510 CALL POSITION(#3,DR,DC):: IF (DR<10)+(DR>192)THEN CALL DELSPRITE(#3)
520 CALL COINC(#1,#3,15,C):: IF C THEN GOSUB 730
530 IF HIT=1 THEN X0=X2
540 NEXT X0 :: IF HIT=1 THEN HIT=0 :: GOTO 550 ELSE CALL DELSPRITE(#3):: GUN=0 :: GOTO 570
550 IF (SCL>=50)THEN LEVEL=LEVEL+1 :: CALL DELSPRITE(ALL):: GOTO 270
560 CALL DELSPRITE(#1,#3):: GOTO 290
570 Y0=Y0+4
580 IF Y0<13 THEN CALL DELSPRITE(#1):: GOTO 480
590 FOR X0=X1 TO X2 STEP -DX :: CALL LOCATE(#1,150,X0)
600 CALL COINC(#1,#2,10,C):: IF C THEN CALL DELSPRITE(#2):: X0=X2
610 NEXT X0
620 FOR I=3 TO 15 STEP 3 :: SPR=276
```

```
    -SPR :: CALL SPRITE(#1,SPR,I+1,
    150,LOK(PF)*8+4):: CALL SCREEN
    (I):: CALL SOUND(-1 0+I*10,-5,3)
    :: NEXT I
630 CALL DELSPRITE(#1)
640 CALL HCHAR(1,NP*2+1,42):: FOR I
    =1 TO 30 STEP 3 :: FOR T=1 TO 3
    0 :: NEXT T :: CALL SOUND(10,22
    0,I):: NEXT I :: CALL HCHAR(1,N
    P*2+1,32)
650 NP=NP-1 :: FOR T=1 TO 5 :: DISP
    LAY AT(24,LOK(DT)):"(3 SPACES)"
    ;:: CALL SOUND(30,220,3):: CALL
     SOUND(40,440,3):: DISPLAY AT(2
    4,LOK(DT)-1):ANS;
660 CALL SOUND(30,220,3):: NEXT T
670 E$="KEEP TRYING !" :: X=25 :: Y
    =12 :: L=16 :: GOSUB 130
680 E$="I KNOW YOU CAN DO IT !" ::
    X=26 :: L=22 :: Y=14 :: GOSUB 1
    30
690 GOSUB 140 :: IF NP=0 THEN 700 E
    LSE 290
700 DISPLAY AT(16,6):"FINAL SCORE "
    ;SC :: DISPLAY AT(18,9):"PLAY A
    GAIN?" :: DISPLAY AT(20,4):"(<F
    IRE> OR PRESS 'Y')"
710 GOSUB 110 :: IF (KK<>18)*(K<>89
    )THEN 710 ELSE 210
720 REM CHECK COLLISION
730 IF ANS=CH(PF)THEN CALL DELSPRIT
    E(#3):: GOSUB 770 :: HIT=1 :: G
    OTO 750
740 CALL COLOR(#1,2):: CALL SOUND(1
    00,147,4,587,4,294,4,-1,3):: CA
    LL COLOR(#1,14)
750 GUN=0 :: RETURN
760 REM DIRECT HIT
770 FOR I=10 TO 30 STEP 5 :: SPR=27
    6-SPR :: CALL SCREEN(I/10+8)::
    CALL SOUND(-100,-6,I):: CALL
    SPRITE(#1,SPR,2+I/4, Y0*8,X0)::
    NEXT I
780 CALL SCREEN(15):: I=Y0/4 :: SC=
    SC+PT(I):: SCL=SCL+PT(I):: DISP
    LAY AT(14,9):PT(I);"POINTS"
790 IF (SCL>=50)*(SCL/PB>20)THEN DI
    SPLAY AT(16,7):"50 BONUS POINTS
    " :: SC=SC+50 :: GOTO 820
800 IF (SCL>=50)*(SCL/PB>=10)THEN D
    ISPLAY AT(16,7):"25 BONUS POINT
    S" :: SC=SC+25 :: GOTO 820
810 GOTO 830
820 FOR I=15 TO 3 STEP -1 :: CALL S
    CREEN(I):: NEXT I :: FOR I=3 TO
     15 :: CALL SCREEN(I):: NEXT I
830 DISPLAY AT(1,23):SC;:: FOR I=1
    TO 350 :: NEXT I :: CALL DELSPR
    ITE(ALL):: RETURN
840 CALL CLEAR :: CALL SCREEN(14)::
     PRINT TAB(6);"MISSILE MATH MEN
    U": : : :
850 PRINT "POSITION BALL WITH JOYST
    ICK/": :
860 PRINT "ARROW KEYS AND FIRE/ENTE
    R TO": :
870 PRINT "SELECT GAME.": :
880 PRINT "TO:": : :: PRINT TAB(7);
    "ADD &";TAB(18);"MULTIPLY &"
890 PRINT TAB(7);"SUBTRACT";TAB(18)
    ;"DIVIDE": : : :
900 PRINT "SLOW": : : : :: PRINT "F
    AST": :
910 FOR J=17 TO 21 STEP 4 :: FOR CO
    L=11 TO 13 :: CALL VCHAR(J,COL,
    120,3):: CALL VCHAR(J,COL+11,12
    0,3):: NEXT COL :: NEXT J
920 FOR J=18 TO 22 STEP 4 :: CALL H
    CHAR(J,12,32):: CALL HCHAR(J,23
    ,32):: NEXT J
930 KHAR=122 :: PX=12 :: PY=18 :: M
    ENU=1 :: DX=9
940 CALL HCHAR(PY,PX,KHAR):: GOSUB
    110 :: KHAR=154-KHAR
950 IF ((SGN(X)=0)*(SGN(Y)=0))THEN
    970
960 CALL HCHAR(PY,PX,32):: IF (SGN(
    X)<>0)THEN MENU=3-MENU :: PX=35
    -PX ELSE PY=40-PY :: DX=27-DX
970 IF (KK=18)+(K=13)THEN RETURN EL
    SE 940
980 REM DEFINE CHARS, COLORS, & MUS
    ICAL SCORE
990 CALL CHAR(120,RPT$("F",16),112,
    "0000183C7E7E183C",122,"8142241
    818244281")
1000 CALL CHAR(96,"0000000003030303
     0303030F3F3F1818"&RPT$("0",22)
     &"C0F0F06060"):: REM BASE
1010 CALL CHAR(124,RPT$("0",11)&RPT
     $("10",6)&RPT$("0",51)):: REM
     MISSILE
1020 CALL CHAR(136,"0000201000000002
     8005103000 8"&RPT$("0",14)&"C4C
     000AC088"&RPT$("0",12)):: REM
     EXPLOSION 1
1030 CALL CHAR(140,"0010010000000080
     0010000 2"&RPT$("0",18)&"800400
     0000000020000000000"):: REM
     EXPLOSION 2
1040 CALL CHAR(128,"0000000000001F7
     FFFE6E67F1F"&RPT$("0",18)&"F8F
     EFF6767FEF8000000"):: REM UFO
1050 CALL MAGNIFY(4):: CALL COLOR(1
     1,13,1)
1060 FOR I=1 TO 14 :: READ NOTE(I),
     DUR(I):: NEXT I :: RETURN
1070 DATA 392,100,392,100,392,100,5
     23,900,392,100,392,100,392,100
1080 DATA 523,100,466,100,440,100,3
     92,700,40000,100,392,360,523,6
     00
1090 RETURN
```

Program 6: Apple Missile Math

```
0  HOME : VTAB 10: HTAB 14: PRINT "LOAD
     ING DATA"
1  GOSUB 1000
5  HOME
10  VTAB 4:A$ = "MISSILE MATH": GOSUB 9
     00
11  PRINT
15  VTAB 6: PRINT "                USE PAD
     DLE 0"
20  VTAB 8
25  PRINT : PRINT "          PRESS SPACE
     TO SELECT"
```

```
26  PRINT : PRINT "          PRESS RETURN
    TO BTART"
30  VTAB 15: PRINT "     ADDITION &
    MULTIPLICATION"
40  PRINT "     SUBTRACTION      & DIVI
    SION"
45 G = 0
49  VTAB 1B
50  PRINT : PRINT "SLOW
                   "
60  PRINT : PRINT "FAST
                   "
70  IF G = 0 THEN  VTAB 19: HTAB 9
71  IF G = 1 THEN  VTAB 21: HTAB 9
72  IF G = 2 THEN  VTAB 19: HTAB 29
73  IF G = 3 THEN  VTAB 21: HTAB 29
74  PRINT "*"
B0  POKE  - 1636B,0
90  IF  PEEK ( - 163B4) < 12B THEN 90
100  GET A$: IF A$ =  CHR$ (13) THEN 20
    0
110  IF A$ <  > " " THEN B0
120 G = G + 1: IF G = 4 THEN G = 0
130  GOTO 49
200 L = 1:SC = 0:S = 3
205  IF G = 0 OR G = 2 THEN  POKE 76B,1
    40: GOTO 210
206  POKE 76B,B0
210  TEXT : HOME : VTAB 7: PRINT "    P
    OSITION GUN OVER CORRECT ANSWER"
220 BN = 0:B0 = 0:B = 0:SH = 0
230  PRINT : PRINT : PRINT "
      AND SHOOT UFO"
240  PRINT : PRINT : PRINT "     BE CAR
    EFUL NOT TO WASTE SHOTS"
250  PRINT : PRINT : PRINT "
     ENTERING LEVEL ";L
260  FOR I = 1 TO 5000: NEXT
270  GR : HOME : VTAB 23: HTAB 25: PRINT
    "SHIPS: ";B
2B0  HTAB 25: PRINT "SCORE: ";SC
290 A =  INT ( RND (1) * 4 + 1) + 4 * (
    L - 1)
291 B =  INT ( RND (1) * 4 * L + 1)
292  IF G < 2 THEN C = A + B: GOTO 294
293 C = A * B
294 A$ =  STR$ (A):B$ =  STR$ (B):C$ =
     STR$ (C)
295 RP =  INT ( RND (1) * 4) + 1
300  IF RP = 1 THEN ANS = A:A$ = "?"
310  IF RP = 2 THEN ANB = B:B$ = "?"
320  IF RP > 2 THEN ANS = C:C$ = "?"
330  VTAB 23: IF G < 2 THEN  PRINT A$"+
    "B$"="C$: GOTO 340
335  PRINT A$"X"B$"="C$
340  IF ANS > 90 THEN DL = 10: GOTO 370
350  IF ANS > 20 THEN DL = 5: GOTO 370
360 DL =  INT ((ANS / 10) + 1)
370 DT =  INT ( RND (1) * 5) + 1
375  VTAB 21
3B0  FOR I = 1 TO 5:CH(I) = ANS + (I -
    DT) * DL: HTAB I * 4 + 4: PRINT CH
    (I);: NEXT
3B5  FOR I = 1 TO 5: IF CH(I) = ANS THEN
     POKE B00,I - 1
3B6  NEXT
390  CALL 24576
395 SH = BH + 1
400 X =  PEEK (769): IF X = 35 THEN 600
500  IF X = 25 THEN B = 5
510  IF X = 15 THEN B = 10
520  IF X = 5 THEN B = 25
521  HOME
525 BN = BN + B
526 BC = BC + B: VTAB 23:A$ =  STR$ (B)
     + " POINTS": GOSUB 900
530  IF BN >  = 50 THEN L = L + 1: GOTO
    700
550  GOTO 260
600 B = S - 1
601  HTAB 1: VTAB 21: PRINT "
                                  ";:A$ =
    "KEEP TRYING": GOSUB 900
602  PRINT :A$ = "I KNOW YOU CAN DO IT"
    : GOSUB 900
603  PRINT :A$ = "THE ANSWER WAS:": GOSUB
    900: PRINT :A$ =  STR$ (ANB): GOSUB
    900
610  FOR I = 1 TO 1000: NEXT
620  IF S = 0 THEN B00
630  GOTO 260
700 BO =  INT (BN / SH + .5)
710  IF BO >  = 25 THEN BO = 50: GOTO 7
    50
720  IF BO >  = 10 THEN BO = 25: GOTO 7
    50
730  GOTO 760
750  VTAB 21
755 A$ = "BONUS: " +  STR$ (BO): GOSUB
    900:BC = BC + BO
760  FOR I = 1 TO 5000: NEXT : GOTO 210
B00  TEXT : HOME : VTAB 5: PRINT "
              BCORE: "SC
B10  PRINT : PRINT : HTAB 1B: PRINT "GA
    ME": PRINT : PRINT : HTAB 1B: PRINT
    "OVER"
B20  VTAB 20: HTAB 5: PRINT "PRESS ANY
    KEY TO PLAY AGAIN"
B30  POKE  - 1636B,0
840  IF  PEEK ( - 16384) < 12B THEN 840
B50  GET A$: GOTO 5
900 X =  LEN (A$):A$ = A$ + " "
910  FOR I = 1 TO X + 19 -  INT (X / 2 +
    .5)
920  HTAB 39 - I: PRINT  MID$ (A$,1,I);
930  NEXT I
940  RETURN
1000 CK = 0
1010  FOR I = 24576 TO 25329: READ A:CK
     = CK + A: POKE I,A: NEXT
1020  IF CK <  > 73926 THEN  PRINT "ERR
    OR IN DATA": END
1030  RETURN
1100  DATA  76,22,96,255,160,160,232,16
    9
1110  DATA  201,197,160,160,176,165,162
    ,160
1120  DATA  12B,6,10,14,18,22,32,46
1130  DATA  96,32,B6,96,32,216,97,32
1140  DATA  111,9B,32,175,9B,173,16,96
1150  DATA  20B,239,32,212,9B,96,169,1
1160  DATA  141,16,96,141,4,96,169,2
1170  DATA  141,5,96,169,33,141,7,96
11B0  DATA  141,B,96,169,5,141,12,96
1190  DATA  141,1,3,169,0,141,13,96
1200  DATA  169,9,141,14,96,96,173,4
1210  DATA  96,205,5,96,240,34,169,0
1220  DATA  32,100,24B,173,4,96,141,3
```

```
1230  DATA  96,32,43,97,169,6,32,100
1240  DATA  248,173,5,96,141,3,96,32
1250  DATA  43,97,173,5,96,141,4,96
1260  DATA  169,0,32,100,248,173,7,96
1270  DATA  141,6,96,173,12,96,141,9
1280  DATA  96,32,126,97,173,14,96,32
1290  DATA  100,248,173,8,96,141,6,96
1300  DATA  173,1,3,141,9,96,32,126
1310  DATA  97,173,8,96,141,7,96,173
1320  DATA  1,3,141,12,96,173,13,96
1330  DATA  201,1,208,68,169,0,32,100
1340  DATA  248,172,2,3,185,17,96,24
1350  DATA  105,2,168,173,10,96,32,0
1360  DATA  248,172,2,3,185,17,96,24
1370  DATA  105,2,168,173,11,96,32,113
1380  DATA  248,201,0,208,28,169,15,32
1390  DATA  100,248,172,2,3,185,17,96
1400  DATA  24,105,2,168,173,11,96,32
1410  DATA  0,248,173,11,96,141,10,96
1420  DATA  96,173,32,3,205,2,3,240
1430  DATA  6,169,15,141,14,96,96,169
1440  DATA  0,141,16,96,169,15,141,14
1450  DATA  96,173,14,96,32,100,248,32
1460  DATA  126,97,32,187,98,206,14,96
1470  DATA  208,239,96,174,3,96,189,17
1480  DATA  96,24,105,2,168,169,36,133
1490  DATA  45,169,34,32,40,248,174,3
1500  DATA  96,189,17,96,168,200,24,105
1510  DATA  3,133,44,169,37,32,25,248
1520  DATA  174,3,96,189,17,96,168,24
1530  DATA  105,4,133,44,169,38,32,25
1540  DATA  248,174,3,96,189,17,96,168
1550  DATA  200,169,39,32,0,248,174,3
1560  DATA  96,189,17,96,168,200,200,20
      0
1570  DATA  169,39,32,0,248,96,173,6
1580  DATA  96,168,24,105,5,133,44,173
1590  DATA  9,96,200,32,25,248,173,6
1600  DATA  96,168,24,105,6,133,44,173
1610  DATA  9,96,24,105,1,32,25,248
1620  DATA  173,6,96,168,24,105,6,133
1630  DATA  44,173,9,96,24,105,2,32
1640  DATA  25,248,173,6,96,168,24,105
1650  DATA  6,133,44,173,9,96,24,105
1660  DATA  3,32,25,248,173,6,96,168
1670  DATA  24,105,5,133,44,200,173,9
1680  DATA  96,24,105,4,32,25,248,96
1690  DATA  162,0,32,30,251,152,201,50
1700  DATA  144,17,201,100,144,18,201,1
      50
1710  DATA  144,19,201,200,144,20,169,4
1720  DATA  76,7,98,169,0,76,7,98
1730  DATA  169,1,76,7,98,169,2,76
1740  DATA  7,98,169,3,76,7,98,141
1750  DATA  5,96,173,8,96,240,6,206
1760  DATA  8,96,76,55,98,169,33,141
1770  DATA  8,96,32,84,98,169,9,141
1780  DATA  14,96,169,0,141,13,96,173
1790  DATA  1,3,24,105,10,141,1,3
1800  DATA  201,35,208,3,76,147,98,173
1810  DATA  13,96,201,1,208,48,173,11
1820  DATA  96,201,2,144,15,206,11,96
1830  DATA  206,11,96,206,11,96,206,11
1840  DATA  96,76,110,98,169,2,141,13
1850  DATA  96,169,0,32,100,248,172,2
1860  DATA  3,185,17,96,24,105,2,168
1870  DATA  173,10,96,32,0,248,96,173
1880  DATA  97,192,48,1,96,173,13,96
1890  DATA  201,0,208,22,169,33,141,10
1900  DATA  96,141,11,96,169,1,141,13
1910  DATA  96,173,4,96,141,2,3,32
1920  DATA  198,98,96,169,0,141,16,96
1930  DATA  169,15,141,14,96,173,14,96
1940  DATA  32,100,248,32,43,97,32,187
1950  DATA  98,206,14,96,208,239,96,174
1960  DATA  0,3,160,0,200,208,253,202
1970  DATA  208,250,96,162,10,160,0,200
1980  DATA  208,253,202,208,250,96,162,
      15
1990  DATA  173,48,192,169,4,32,168,252
2000  DATA  202,208,245,96,169,16,141,1
      5
2010  DATA  96,160,1,162,1,169,80,32
2020  DATA  168,252,173,48,192,232,208,
      253
2030  DATA  136,208,240,206,15,96,208,2
      33
2040  DATA  96,255,0,0,255,255,0,0
```

Program 7: PC/PCjr Missile Math

```
10 WIDTH 40:KEY OFF:SCREEN 0,1:DEF SEG=0
:POKE 1047,64:DEFINT A-Z
20 GOSUB 610:GOSUB 450:GOSUB 480:GOSUB 5
10:GOTO 110
30 IF Y2=N21 THEN RETURN ELSE C$=INKEY$:
IF C$="." AND H<N28 THEN LOCATE N21,H:PR
INT "  ":H=H+N5
40 IF C$="," AND H>N9 THEN LOCATE N21,H:
PRINT "  ":H=H-N5:Z=RND(1)
50 IF C$=CHR$(N32) AND FIRE =N0 AND FI=N
0 THEN FIRE=N1:FI=N1:Y=N20:X=H+N1:PANS=C
H((H-N3)/N5):NS=NS+N1:Z=RND(1):RETURN
60 LOCATE N21,H:COLOR N3:PRINT BASE$:RET
URN
70 X2=X2-N1:IF X2=N1 THEN LOCATE Y2,X2+N
1:PRINT "    ":Y2=Y2+N5:X2=N35:FI=N0:R=N
4
80 SP=SCREEN(Y2,X2):IF SP=21 THEN FL=2:K
=S:RETURN:ELSE IF SP=202 THEN FL=3:K=S:R
ETURN
90 LOCATE  Y2,X2:COLOR R:PRINT SPCE$:RET
URN
100 COL=COL+1:IF COL=8  THEN COL =2
110 COLOR COL:CLS:W$="ENTERING LEVEL"+ST
R$(LVL):YY=12:GOSUB 590:GOSUB 630
120 IF NS THEN IF NS<3 THEN W$="50 POINT
 BONUS":YY=14:GOSUB 600:ELSE IF NS<6 THE
N W$="25 POINT BONUS":YY=14:GOSUB 600
130 FOR TD=1 TO 1000:NEXT:SCL=0:NS=0
140 CLS:LOCATE 2,1:FOR J=1 TO NM:COLOR 1
3:PRINT CHR$(6)" ";:NEXT
150 LOCATE 2,29:PRINT"SCORE "SC
160 X2=36:Y2=6:T=INT(RND(1)*20)+40:FL=1:
FI=0:FIRE=0:R=4
170 A=INT(RND(1)*4+1)+4*(LVL-1)
180 B=INT(RND(1)*4*LVL+1)
190 IF P$="A" THEN C=A+B:GOTO 210
200 C=A*B
210 A$=STR$(A):B$=STR$(B):C$=STR$(C)
220 RP=INT(RND(1)*4)+1
230 IF RP=1 THEN ANS=A:A$=CHR$(63)
240 IF RP=2 THEN ANS=B:B$=CHR$(32)+CHR$(
63)
250 IF RP=3 OR RP=4 THEN ANS=C:C$=CHR$(3
2)+CHR$(63)
260 IF P$="A" THEN LOCATE 4,14:COLOR 7:P
RINT A$" +"B$" ="C$:GOTO 280
```

```
270 COLOR 7:LOCATE 4,14:PRINT A$" X"8$"
="C$
280 IF ANS>90 THEN DEL=10:GOTO 320
290 IF ANS>20 THEN DEL=5:GOTO 320
300 DEL=INT((ANS/10)+1)
310 DT=INT(RND(0)*5)+1
320 FOR I=1 TO 5:CH(I)=ANS+(I-DT)*DEL:LO
CATE 22,5*I+3:PRINT CH(I):NEXT I
330 GOSUB 30:GOSUB 410:T=T-N1:IF T<N0 TH
EN FOR K=N1 TO S:GOSUB 410:GOSUB 70:NEXT
:GOSUB 410
340 ON FL GOTO 330,350,370
350 R=N7:FL=N1:IF ANS<>PANS THEN 330 ELS
E FOR TI=N1 TO N3:COLOR TI:LOCATE Y2-N1,
X2:PRINT E1$:LOCATE Y2,X2:PRINT E2$:LOCA
TE Y2+N1,X2:PRINT E3$:LOCATE Y2+N2,X2:PR
INT P(Y2)" POINTS":FOR TD=37 TO 45:SOUND
 TD,.5:NEXT TD,TI:FIRE=0:FOR TD=1 TO 900
:NEXT
360 SC=SC+P(Y2):SCL=SCL+P(Y2):IF SCL>=50
 THEN LVL=LVL+1:SCL=0:GOTO 100:ELSE 140
370 NM=NM-1:SOUND 100,20:FOR TD=1 TO 600
:NEXT:SOUND 37,20:FOR TI=1 TO 5:FOR TD=1
 TO 600:NEXT:LOCATE 22,5*DT+3:PRINT "
 ":FOR TD=1 TO 60:NEXT:LOCATE 22,5*DT+3:
COLOR 4:PRINT CH(DT):FOR TD=1 TO 60:NEXT
:NEXT
380 IF NM>0 THEN W$="KEEP TRYING":YY=10:
GOSUB 590:GOSUB 630:GOTO 140
390 LOCATE 2,1:PRINT " ":W$="PLAY AGAIN
?(Y/N)":YY=10:GOSUB 590
400 I$=INKEY$:IF I$="Y" THEN RUN ELSE IF
 I$="N" THEN CLS:END:ELSE 400
410 IF FIRE=N0  THEN FOR TD=1 TO 10:NEXT
:RETURN
420 Y=Y-1:IF Y=5 THEN FIRE=0:LOCATE Y+1,
X:PRINT " ":RETURN
430 SP=SCREEN(Y,X):IF SP <>32 THEN FL=2
440 SOUND 200-Y*3,.1:LOCATE Y,X:COLOR 14
:PRINT MISS$:RETURN
450 CLS:W$="MISSILE MATH !":YY=10:COLOR
2:GOSUB 590:FOR TD=1 TO 800:NEXT
460 COLOR 3:W$="< MOVES YOU LEFT":YY=12:
GOSUB 590:COLOR 4:W$="> MOVES YOU RIGHT"
:YY=14:GOSUB 600:LOCATE 16,11:COLOR 7:PR
INT "SPACE BAR TO FIRE":GOSUB 630:RETURN
470 FOR TD=1 TO 2000:NEXT:CLS:RETURN
480 SPCE$=CHR$(17)+STRING$(2,219)+CHR$(1
74)+CHR$(32)+CHR$(32):BASE$=CHR$(32)+CHR
$(202)+CHR$(32):MISS$=CHR$(21)+CHR$(31)+
CHR$(29)+CHR$(32):E1$=CHR$(92)+STRING$(2
,179)+CHR$(47):E2$=CHR$(196)+STRING$(2,3
2)+CHR$(196)+CHR$(32)
490 E3$=CHR$(47)+STRING$(2,179)+CHR$(92)
500 H=28:LVL=1:NM=3:N1=1:N21=21:N32=32:N
28=28:N0=0:N2=2:N3=3:N202=202:N5=5:N9=9:
N32=32:N20=20:N35=35:N4=4:N7=7:DIM P(16)
:P(6)=25:P(11)=10:P(16)=5:COL=2:RETURN
510 CLS:LOCATE 8,8,0:COLOR 7:PRINT "(A)D
DITION AND SUBTRACTION":LOCATE 10,19:PRI
NT"OR"
520 LOCATE 12,7 :PRINT"(M)ULTIPLICATION
AND DIVISION"
530 P$=INKEY$:IF P$<>"A"AND P$<>"M" THEN
 530
540 LOCATE 15,12:PRINT "(F)AST OR (S)LOW
"
550 S$=INKEY$:IF S$="S" THEN S=1 ELSE IF
 S$="F" THEN S=2 ELSE 550
560 LOCATE 21,11:PRINT "HIT ANY KEY TO S
TART"
570 Z=RND(1):I$=INKEY$:IF I$=""THEN 570
580 RETURN
590 W=LEN(W$):NW$=W$+STRING$(20-W/2,32):
FOR K=1 TO LEN(NW$):LOCATE YY,39-K,0:PRI
NT LEFT$(NW$,K):NEXT:RETURN
600 W=LEN(W$):NW$=STRING$(18-W/2,32)+W$:
FOR K=1 TO LEN(NW$):LOCATE YY,1:PRINT RI
GHT$(NW$,K):NEXT:RETURN
610 DIM NO(14,2):FOR A=1 TO 14:FOR 8=1 T
O 2:READ NO(A,8):NEXT B,A:RETURN
620 DATA 196,1,196,1,196,1,261,9,196,1,1
96,1,196,1,261,1,232,1,220,1,196,7,32000
,1,196,3,261,6
630 FOR R1=1 TO 14:SOUND NO(R1,1),NO(R1,
2)*1.5:FOR TD=1 TO NO(R1,2)*90 :NEXT:NEX
T:RETURN
```


STOP PLAYING GAMES

NEW Disk Commodore 64

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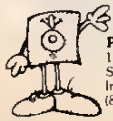

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Lightsaver

Jon Rhees

The world is depending on you to save its supply of light bulbs. A quick eye and an even faster hand are the only two things that will help you. This arcade-style action game uses machine language for fast action. Versions are included for the Commodore 64 and VIC-20, the Atari home computers, and the IBM PC/PCjr.

Technology has backfired again! A dangerous power surge has transformed the light fixture in your room into a devilish lamp, which is trying to rid the world of light bulbs by tossing them to the ground. Only you can stop the lamp from carrying out its horrid plan. You must catch the bulbs in your baskets before they hit the ground and break. The more bulbs you save, the more angry the lamp will become, and the faster it will drop bulbs. How long can you survive the wrath of the lamp?

"Lightsaver" is a fast-action, arcade-style game which utilizes many of the capabilities of the Commodore 64. Most of the action in this game is written in machine language for speed, while the scoring and setup routines are written in BASIC. The game requires a set of paddle controllers, which should be plugged into port 1.

The object of the game is simple: catch as many light bulbs as you can without missing or dropping any. You must catch each bulb in your baskets. At the beginning of a game you start out with three baskets, stacked atop each other. You position the baskets by turning the paddle controller. Each time you miss a bulb, you lose a basket, and are set back one level. Each consecutive level has more bulbs to catch and faster action. Bonus baskets are awarded every 2000 points, but you can have only three baskets at a time. Also, the higher the level you are on, the more points each bulb you catch is worth.

There are 16 skill levels in Lightsaver and two basket sizes. The higher the skill level you choose, the faster the game. Bulbs are easier to catch with a large basket than with a small one. A large basket is twice as wide as a small one. You can change the basket size during the game by pressing the f1 key. Press the paddle fire button to start a new round.

Lightsaver takes advantage of the sprite, redefined character, color, and sound capabilities of the 64. It contains two separate machine language routines—one for the game action, and another to quickly copy the character ROM into RAM for programmable characters. A demo mode is also included. The computer plays a game against itself if left alone. All eight sprites are used, as well as a redefined character set. The first two voices of the SID (Sound Interface Device) chip are used for sound effects, and the third voice is used as a random number generator for the machine language routine.

If you'd rather not type in the program, you can obtain tape or disk copies (64 version only). Send an SASE, a disk or tape, and $3 to:

Jon Rhees
1660 S. Duneville
Las Vegas, NV 89102

Program 1: 64 Lightsaver

Refer to the "Automatic Proofreader" article before typing this program in.

```
1 GOSUB550                                :rem 75
2 Z=646:POKE53280,0:POKE53281,0:POKEZ,1:X
  =58692:SYSX:V=53248                     :rem 89
3 G=54272:POKEG+6,0:POKEG+5,0:POKEG+4,0:P
  OKEG+6,240:POKEG+4,17:POKEG+24,143
                                          :rem 122
4 POKEG+6,240:NS$="000000":GOSUB400
                                          :rem 187
10 T=49152:H=54273:B=832:C=1022:E=49550:F
   ORA=BTOC:READM:POKEA,M:POKEH,M:NEXT
                                          :rem 131
20 B=V+39:FORA=TTOE:READM:POKEA,M:POKEH,M
   :POKEB,M:NEXT:POKEG+5,186:POKEG+6,.
                                          :rem 124
26 POKE252,208:POKE251,.:POKE253,.:BL=872
   :POKE254,48                            :rem 240
28 POKE56334,.:POKE1,51:SYS49490:POKE4951
   3,56:POKE49500,145:POKE49501,253
                                          :rem 208
29 POKE49502,200:POKE49503,234:SYS49490:P
   OKE1,55:POKE56334,1:GOTO600    :rem 214
60 POKE53280,3:SYSX:PRINT"{5 DOWN}
   {7 SPACES}SELECT SKILL LEVEL (A-P) ";
                                          :rem 232
61 GETA$:SL=ASC(A$+" ")-59:IFSL<6 OR SL>2
   1 THEN 61                              :rem 170
62 PRINTA$:POKE53280,14:PRINT:PRINT"
   {3 DOWN}{7 SPACES}SELECT BASKET SIZE (
   S/L) ";:P=.                            :rem 95
```

Notes For VIC-20, Atari, And IBM PC/PCjr Versions

In "Lightsaver," you must catch light bulbs that fall from a lamp at the top of the screen.

The VIC Version

Program 2, for the unexpanded VIC-20, is written entirely in machine language and offers five levels of play. The level selected affects the speed of the falling bulbs at the beginning of play. The speed increases when a light bulb is caught in your basket and decreases when light bulbs crash to the bottom of the screen. The game ends when three bulbs have been missed.

You move your baskets under the falling bulbs by using a paddle plugged into the control port.

Since the VIC version is written in machine language, you must use a special technique to enter the program. You must first type in the "Tiny MLX" program found elsewhere in this issue, and then use this program to type VIC Lightsaver. Be sure you read and understand the Tiny MLX article before you begin typing Lightsaver. Also, remove or disable any memory expanders. Once you have typed in Lightsaver, and saved it to tape or disk using MLX, you can load and run the program just as you would a BASIC program.

The Atari Version

To catch bulbs in the Atari version of Lightsaver, you must move your basket with the paddle controller and touch the bulbs before they hit the bottom of the screen. If a light bulb reaches the bottom of the screen, it will break and you will lose one of your three baskets. The number of points awarded for catching a bulb is equal to the current level. For instance, on the fourth level, every bulb that you catch is worth four points. You are given an additional basket every 2000 points. Each time you complete five levels, the speed of the light bulbs increases.

Atari Lightsaver has been split into two programs so it will work on 16K computers with DOS. Load and run Program 3. This program loads two machine language subroutines and the redefined character set. When finished, this program will load and run Program 4. Program 4 (the main program) contains the player missile graphics and the main game loop. Since Program 3 loads and runs Program 4, disk users must save both programs on the same disk. Program 4 must be saved with filename LIGHTSAVER.

Cassette users must change line 1046 in Program 3 to:

```
1046 READ A: IF A=-1 THEN PRINT "HIT RETURN TO LOAD LIGHTSAVER": RUN "C:"
```

Next, rewind a tape to a blank section, press the PLAY and RECORD buttons, and enter SAVE "C:" to store Program 3. When the cassette is finished, type in Program 4. Save Program 4 immediately following Program 3 by once again entering SAVE "C:". To load and run the two programs, rewind the tape to the start of Program 3 and type RUN "C:".

The IBM Version

In the IBM version of Lightsaver (Program 5), you must catch bulbs before they fall below basket level. The IBM version has only one difficulty level and a constant basket size. Game play consists of several rounds, each consisting of a barrage of dropping bulbs. Between 10 and 20 bulbs are dropped before the round ends. Each additional round increases the motion of the lamp which drops the bulbs and increases the number of points awarded. The formula is simple: The number of points awarded equals the number of bulbs caught, multiplied by the difficulty level.

You can catch a bulb only if it drops into the basket from above. It is possible to break a bulb by hitting it with the rim of your basket. If you let a bulb break, the round ends and the difficulty level decreases by one.

IBM Lightsaver will run on PCs with Advanced BASIC (BASICA) and PCjrs with DOS and Cartridge BASIC. A Color/Graphics Monitor Adapter card is needed on PCs. A joystick is required to control the left-right movement of the baskets.

Since the video display processor of the IBM PC may refresh the screen while we are using the PUT statement to place graphics on the screen, a short machine language routine has been included to synchronize PUT with the vertical retrace interval.

```
                MOV DX,3DAh
CHECKPORT       IN AX,DX
                AND AX,8
JZ CHECKPORT
RETF
```

This machine language routine reduces flicker when the baskets are moved around the screen.

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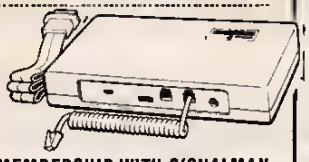

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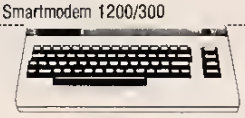

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```
63 GETS$:IFS$<>"S"ANDS$<>"L"THEN63
                                        :rem 253
64 PRINTS$"{5 DOWN}":POKE53280,6:LV=.:POK
   E209,88:POKE210,6:IFBW=141THENGOSUB500
                                        :rem 146
65 PRINT"PRESS <F1> TO CHANGE BASKET SIZE
    IN PLAY":GOSUB700                   :rem 22
67 POKE63,.:POKE65,.:POKE67,.:SYSX:NS$="0
   00000":GOSUB202                      :rem 60
68 POKEV+29,-(S$="L"):GOSUB340:GOTO71
                                        :rem 163
70 GOSUB200                             :rem 121
71 PRINT"{HOME}{17 DOWN}{2 SPACES}{GRN}PR
   ESS FIRE BUTTON WHEN READY!"         :rem 226
72 N=244-PEEK(54297):N=N*-(N>=24)-24*(N<2
   4):POKEV,N                           :rem 93
73 POKEV+29,(PEEK(V+29)-(PEEK(197)=4))AND
   1:IF(PEEK(56321)AND4)THEN72          :rem 158
74 PRINT"{UP}{31 SPACES}":POKE254,.:SYST:
   IFPEEK(68)THEN80                     :rem 252
76 M=54273:POKEF+11,.:N=5:I=125:J=53280:F
   ORA=NTOISTEP3:POKEJ,A                :rem 15
77 POKEM,AAND(LV+5)*2:NEXT:POKEF+5,186:PO
   KEF+6,.:POKEF+12,186:POKEF+13,.:rem 54
79 POKEJ,.:GOTO70                       :rem 29
80 POKEF+11,.:POKEF+4,.:POKEF+1,186:POKEF
   +4,129:POKEF+5,188:POKEF+6,.         :rem 30
81 POKEV+4,PEEK((PEEK(781)+4)+V):POKEV+5,
   232:B=50:D=-.9:E=V+3:F=10264         :rem 175
82 FORA=8TO.STEPD:POKEE,A:N=RND(.)*21:M=N
   *1.4:POKEN+BL,PEEK(N+BL)ANDRND(.)*256
                                        :rem 23
83 POKEM+F,PEEK(M+F)ORRND(.)*256:POKE780,
   M:SYS49540:NEXT:POKEV+41,0:POKE53281,0
                                        :rem 47
84 LV=LV-2:P=P+1:POKEV+2,.:LV=LV*-(LV>-1)
   :FORA=BLTOBL+20:POKEA,.              :rem 197
85 NEXT:BL=BL-20:IFBW=141THENGOTO600
                                        :rem 1
86 GOSUB200:IFP<3THENGOSUB340:GOTO71
                                        :rem 41
88 IFVAL(NS$)=VAL(HS$)ANDVAL(NS$)>0THENGO
   TO900                                :rem 99
90 POKEV+21,.:PRINT"{HOME}{7 DOWN}{CYN}"S
   PC(9)"** GAME OVER **":BL=872:P=.
                                        :rem 87
96 GOSUB800:GOTO600                     :rem 144
100 DATA 255,255,255,109,182,218,27
                                        :rem 192
101 DATA 109,180,13,182,216,11,109,176
                                        :rem 69
102 DATA 7,255,224,0,0,0,255,255,255
                                        :rem 220
103 DATA 91,109,182,45,182,216,27,109
                                        :rem 33
104 DATA 176,13,182,208,7,255,224,0,0,0
                                        :rem 109
105 DATA 255,255,255,109,182,218,27,109
                                        :rem 139
106 DATA 180,13,182,216,11,109,176,7
                                        :rem 231
107 DATA 255,224,0,0,0,0,0,60,0,0,60,0
                                        :rem 22
108 DATA 0,60,0,0,60,0,0,60,0,0,60,0,0
                                        :rem 11
109 DATA 60,0,0,60,0,0,60,0,0,60,0,0,60
                                        :rem 66
110 DATA 0,0,60,0,0,60,0,0,60,0,0,60,0
                                        :rem 4
111 DATA 0,20,0,0,85,0,1,85,64,5,85,80
                                        :rem 50
112 DATA 21,85,84,170,170,170,0,0,0,0,0
                                        :rem 90
113 DATA 0,0,0,0,0,0,0,0,0,0,24,0,0,60,0
                                        :rem 247
114 DATA 0,60,0,0,36,0,0,126,0,0,126,0
                                        :rem 21
115 DATA 0,255,0,1,255,128,1,255,128,3
                                        :rem 60
116 DATA 253,192,1,253,128,1,251,128,0
                                        :rem 66
117 DATA 255,0,0,60,0,0,0,0,0,0,0,0,0,0
                                        :rem 49
118 DATA 120,173,2,220,72,169,192,141,2
                                        :rem 117
119 DATA 220,169,64,141,0,220,160,128
                                        :rem 19
120 DATA 234,136,16,252,56,169,220,237
                                        :rem 79
121 DATA 25,212,176,2,169,0,24,105
                                        :rem 122
122 DATA 24,141,0,208,104,141,2,220,88
                                        :rem 54
123 DATA 172,30,208,169,8,133,253,162,2
                                        :rem 123
124 DATA 254,5,208,189,4,208,240,33,169
                                        :rem 135
125 DATA 188,56,253,5,208,176,13,152,37
                                        :rem 139
126 DATA 253,240,8,169,0,157,4,208,76
                                        :rem 35
127 DATA 14,193,189,5,208,201,232,208,5
                                        :rem 128
128 DATA 169,1,133,68,96,232,232,6,253
                                        :rem 88
129 DATA 224,12,240,3,76,51,192,234,164
                                        :rem 125
130 DATA 197,192,4,208,17,165,255,201
                                        :rem 32
131 DATA 64,208,11,169,1,24,109,29,208
                                        :rem 75
132 DATA 41,1,141,29,208,132,255,164,64
                                        :rem 120
133 DATA 240,99,132,64,173,2,208,24,101
                                        :rem 120
134 DATA 254,141,2,208,198,2,16,84,169
                                        :rem 86
135 DATA 31,160,0,133,2,173,27,212,133
                                        :rem 55
136 DATA 254,56,237,2,208,176,8,173,2
                                        :rem 37
137 DATA 208,56,229,254,160,1,74,74,74
                                        :rem 91
138 DATA 74,74,133,254,56,233,4,176,225
                                        :rem 140
139 DATA 192,1,208,9,165,254,169,0,56
                                        :rem 41
140 DATA 229,254,133,254,230,66,230,66
                                        :rem 79
141 DATA 166,66,224,10,208,4,162,0,134
                                        :rem 65
142 DATA 66,169,80,157,7,208,173,2,208
                                        :rem 90
143 DATA 157,6,208,234,234,206,64,0
                                        :rem 183
144 DATA 169,146,133,150,198,150,165
                                        :rem 247
145 DATA 150,141,1,212,230,9,165,9,141
                                        :rem 63
146 DATA 8,212,201,30,208,3,141,11,212
                                        :rem 50
```

```
147 DATA 172,52,3,32,204,255,32,204,255
                                    :rem 120
148 DATA 136,192,0,208,248,76,0,192,165
                                    :rem 138
149 DATA 251,248,24,101,67,133,67,169,0
                                    :rem 135
150 DATA 101,65,133,65,169,0,101,63,133
                                    :rem 113
151 DATA 63,216,162,4,181,63,72,41,15
                                     :rem 23
152 DATA 24,105,48,157,19,5,104,74,74
                                     :rem 33
153 DATA 74,74,24,105,48,157,18,5,202
                                     :rem 32
154 DATA 202,16,230,169,129,141,11,212
                                     :rem 65
155 DATA 169,0,133,9,198,252,208,3,133
                                     :rem 84
156 DATA 68,96,76,92,192,160       :rem 122
157 DATA 0,177,251,17,253,145,253,177,251
    ,74,200,145,253,208,242         :rem 86
158 DATA 230,252,230,254,165,254,201,52
                                    :rem 123
159 DATA 208,230,96,234,238,0,201,174,0
                                    :rem 124
160 DATA 201,189,0,200,168,138,105,109
                                     :rem 71
161 DATA 170,173,2,208,157,0,200,234,140,
    141,41,208,141,32,208,141,33,208,96,3
    2                               :rem 22
162 DATA 48,126,103,103,103,103,103,127
                                    :rem 106
163 DATA 63,49,28,60,124,28,28,28,127
                                     :rem 41
164 DATA 63,50,126,103,7,127,112,115,127
                                    :rem 166
165 DATA 63,51,126,103,7,63,7,103  :rem 81
166 DATA 127,63,52,6,15,27,51,127,127
                                     :rem 32
167 DATA 7,15,53,126,96,126,103,7,103
                                     :rem 29
168 DATA 127,63,54,126,103,96,126,103
                                     :rem 34
169 DATA 103,127,63,55,126,103,7,14,28
                                     :rem 78
170 DATA 28,28,28,56,126,103,103,127
                                    :rem 234
171 DATA 103,103,127,63,57,126,103,103
                                     :rem 63
172 DATA 127,7,103,127,63,104,0,0,0,0
                                    :rem 253
173 DATA 239,239,85,254            :rem 125
200 NS$="":FORA=1298TO1303:NS$=NS$+CHR$(P
    EEK(A)):NEXT                    :rem 99
201 AA=INT(VAL(NS$)/2000)-INT(Q/2000):IFA
    ATHENGOSU8300                   :rem 176
202 Q=VAL(NS$):IFQ>=VAL(HS$)THENHS$=NS$
                                    :rem 147
204 POKE53280,.:LV=LV+1:LV$=STR$(LV)+"
    {2 SPACES}":IFLV>1THEN208       :rem 151
206 FORA=1024TO1057STEP2:POKEA,95:POKEA+1
    ,105:POKE54272+A,4:POKE54273+A,10:NEX
    T                               :rem 199
207 FORA=1984TO2023:POKEA,104:POKEA+54272
    ,12:NEXT                        :rem 138
208 PRINTCHR$(19)CHR$(159)CHR$(18)SPC(34)
    CHR$(169)"LIGHT"CHR$(146);:POKEZ,13
                                    :rem 86
209 PRINTSPC(34)CHR$(127)CHR$(18)"SAVER":
    POKEZ,7:PRINTSPC(74)"SCORE:"SPC(74);
                                    :rem 152
210 PRINTCHR$(5)NS$:POKEZ,8:PRINTSPC(76)"
    HI"SPC(76)"SCORE:"SPC(74)CHR$(5)HS$
                                     :rem 89
211 PRINTSPC(34);:POKEZ,6:PRINT"*";:POKEZ
    ,10:PRINTHU$;:POKEZ,6:PRINT"*"
                                    :rem 252
212 POKEZ,14:PRINTSPC(74)"LEVEL:"SPC(75)C
    HR$(5)LV$:F=54272:POKEF+20,128
                                    :rem 194
216 POKE2040,13:POKE2041,14:POKEF+19,.
                                    :rem 125
220 POKEV+1,205:POKEV+3,50:POKEV+23,3:POK
    EV+28,2:POKEV+39,7:POKEF+18,.:rem 156
222 FORA=4TO14STEP2:POKEV+A,.:POKEV+A+1,A
    *8+140:POKE2040+A/2,15:NEXT     :rem 71
223 FORA=1024TO1030:POKEA,.:NEXT:POKE20
    42,160:POKE66,.:POKE2,.         :rem 34
226 POKEV+37,12:POKEV+38,14:FORA=41TO46:P
    OKEV+A,1:NEXT:POKEV+21,255:POKEF+19,.
                                    :rem 238
228 POKEF+11,0:POKEF+7,0:POKEF+13,128:POK
    EF+12,.:K=260-SL*LV:POKEF+20,128
                                    :rem 248
230 POKE64,LV*2+9:POKE252,LV*2+9:LN=LV:PO
    KEF+15,255:IFLN>100THENLN=100:rem 208
232 POKE251,INT(LN/10)*16+LN-INT(LN/10)*1
    0:POKEF+14,.:POKEF+18,129:IFK<1THENK=
    1                               :rem 113
233 POKEF+1,.:POKEF+4,.:POKEF+5,.:POKEF+6
    ,128:POKEF,.:POKEF+24,143:POKEF+4,33
                                     :rem 24
234 POKE820,K:POKEV+41,.:RETURN    :rem 156
300 F=54272:POKEF+4,.:POKEF+5,128:POKEF+6
    ,128:POKEF+4,17:REM EXTRA BASKET
                                     :rem 45
301 FORA=1TO4:ST(A)=PEEK(62+A):NEXT:BL=BL
    +20*AA:IFBL>872THENBL=872       :rem 17
303 P=P-AA:P=P*-(P>.):RESTORE       :rem 251
310 RESTORE:FORA=832TO832+20*(3-P):READM:
    POKEA+1,.:POKEA,M               :rem 18
330 POKEF+1,INT(RND(.)*256):NEXT:FORA=1TO
    4:POKE62+A,ST(A):NEXT:POKEF+1,.:RETUR
    N                               :rem 179
340 POKEF+4,.:POKEF+5,128:POKEF+6,128:POK
    EF+4,33:B=28+INT(RND(.)*8)*32:C=.
                                    :rem 216
345 FORA=CTO8:POKEV+2,A:POKEF+1,AAND10:NE
    XT:POKEF+4,.                    :rem 63
350 POKEF+6,128:POKEF+5,.:POKEF+4,33:POKE
    F+1,.:RETURN                    :rem 189
400 PRINT"{CLR}{6 DOWN}{2}{RVS}{*}
    {8 RIGHT}{CYN} ":PRINT"{2}{RVS}
    {8 RIGHT}{CYN} {4 RIGHT}{6} ":POKE204
    0,15                            :rem 114
410 PRINT"{2}{RVS} {8 RIGHT}{CYN}
    {4 RIGHT}{6} ":POKEV+1,101:POKEV+39,1
    :POKEV,32:POKEV+21,1            :rem 39
420 PRINT"{2}{RVS} {RIGHT}{YEL} {RIGHT}
    {5}£{3 SPACES}{RIGHT}{CYN} £ {*}{6}
    {OFF}{*}{RVS}{2 SPACES}{RIGHT}{PUR}£
    {2 SPACES}{OFF}£{RVS}{RIGHT}{RED}£
    {2 SPACES}{*}{RIGHT}{8LU} {2 RIGHT}
    {RIGHT}{GRN}£ {*}{RIGHT}{3} £{*}":P
    OKEV+29,.                       :rem 26
430 PRINT"{2}{RVS} {RIGHT}{YEL} {RIGHT}
    {5} {2 RIGHT} {RIGHT}{CYN} {OFF}£
    {RVS}{RIGHT} {RIGHT}{6} {2 RIGHT}
    {PUR}{OFF}{*}{@}{2 RIGHT}{RVS}{RIGHT}
    {RED} {2 RIGHT} {RIGHT}{8LU}
    {2 RIGHT} {RIGHT}{GRN} {OFF}{P}{RVS}
```

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    {SPACE}{RIGHT}[3] {OFF}£[*]":POKEV+2
    3,.                                 :rem 185
440 PRINT"[2]{RVS} {RIGHT}{YEL} {RIGHT}
    [5] {2 RIGHT} {RIGHT}{CYN} {2 RIGHT}
    {SPACE}{RIGHT}[6] {RIGHT}£{2 RIGHT}
    {PUR}{OFF}[T]{RVS}[*]{RIGHT}{RED}
    {2 RIGHT} {RIGHT}{BLU}{OFF}[*]{RVS}
    [*]£{OFF}£{RVS}{RIGHT}{GRN}
    {3 RIGHT}[3] "                      :rem 87
450 PRINT"[2]{RVS} {RIGHT}{YEL}{OFF}[*]
    {RIGHT}[5][*]{RVS}{3 SPACES}{RIGHT}
    {CYN} {2 RIGHT} {RIGHT}[6]{OFF}[*]
    {RVS} {OFF}£{RVS}{PUR}£{2 SPACES}
    {OFF}£{RIGHT}{RED}[*]{RVS} {OFF}£
    {RVS} {2 RIGHT}{BLU}{OFF}[*]£
    {2 RIGHT}{GRN}[*]{RVS} {OFF}£{RIGHT}
    {RVS}[3] "                          :rem 18
460 PRINT"[2](RVS} (6 RIGHT}[5] ":PRINT"
    [2]{RVS} {3 RIGHT}[5]{OFF}[*]{RVS}
    {2 SPACES}{OFF}£":PRINT"[2]{RVS}
    {4 SPACES}[*]{3 DOWN}"              :rem 123
470 PRINT"{WHT}{4 SPACES}USE PADDLES IN P
    ORT ONE TO PLAY.":RETURN            :rem 58
500 QW=49164:RW=49517                   :rem 172
510 FORAW=.TO22:8W=PEEK(AW+QW):POKEAW+QW,
    PEEK(AW+RW):POKEAW+RW,8W:NEXT:rem 109
520 IFBW=141THENPOKE49262,96:POKE49230,63
    :POKE49378,52:POKE49379,3:GOTO540
                                        :rem 129
530 POKE49262,165:POKE49230,14:POKE49378,
    64:POKE49379,0:POKE49481,252:RETURN
                                        :rem 199
540 POKE49481,255:RETURN                :rem 180
550 IFPEEK(51457)=114THENGOTO560        :rem 123
552 HS$="000000":HU$="C-64":GOSU8590
                                        :rem 170
560 HT$="":FORA=51458TO51467:HT$=HT$+CHR$
    {PEEK(A)}:NEXT                      :rem 208
562 HS$=LEFT$(HT$,6):HU$=RIGHT$(HT$,4}
                                        :rem 166
564 RETURN                              :rem 127
590 HT$=HS$+HU$+" ":FORA=1TOLEN(HT$):POKE
    51457+A,ASC{MID${HT$,A,1}):NEXT:RETUR
    N                                   :rem 179
600 POKE53269,.:IFPEEK(49164)=141THENGOSU
    8500:IFSL=0THENSYSX:NS$="000000"
                                        :rem 129
605 POKE53272,28:PRINT"{HOME}{12 DOWN}
    {YEL}{6 SPACES}PRESS <F1> TO START...
    "                                   :rem 36
607 IFSL=0THENSL=6:GOSU8700             :rem 202
610 GOSUB202:GOSUB340:POKE254,0:POKE820,2
    55:POKE68,0:SYST                    :rem 231
620 IFP=2THENP=1:BL=BL+20               :rem 243
630 IFPEEK(68)=1THENGOTO80              :rem 74
640 BL=872:SYSX:POKE54296,0:POKE53269,0:P
    OKE53280,0:GOSUB800:GOTO60          :rem 38
700 RESTORE:B=589:FORA=.TOB:READM:NEXT:FO
    RA=.TO10:READM:J=M*8+12288          :rem 252
710 FORB=.TO7:READM:POKEB+J,M:NEXTB,A:RET
    URN                                 :rem 132
800 RESTORE:FORA=832TO895:READM:POKEA,M:N
    EXT:POKE54273,.:RETURN              :rem 98
900 F=54272:FORA=0TO24:POKEF+A,.:NEXT:A$=
    "* HIGH SCORER *":POKE646,6:GOSUB990
                                        :rem 15
910 POKE646,7:POKEF+6,240:POKEF+4,17:POKE
    F+24,143                            :rem 68
920 FORA=1TOLEN(A$):FORB=.TO200STEP10:POK
    EF+1,B:NEXT:PRINTMID$(A$,A,1)"{RIGHT}
    ";:NEXT                             :rem 85
930 POKEF+24,140:A=1397                 :rem 239
940 PRINT,"{13 DOWN}{CYN} TURN PADDLE TO
    {SPACE}CHOOSE LETTERS..{DOWN}"
                                        :rem 253
941 PRINT" PUSH BUTTON TO MOVE CURSOR"
                                        :rem 67
942 PRINT"{HOME}{9 DOWN}[6]{15 SPACES}[@]
     [@] [@]":HU$=""                    :rem 29
943 POKEA+40,30:POKEA+F+40,10:POKEF+A,1
                                        :rem 221
945 8=29-PEEK{54297}/9:POKEA,B:POKE646,(P
    EEK(646)+1)AND255:GOSUB990          :rem 125
950 POKEF+1,B*8+15:IFPEEK{56321)AND4THENG
    OTO945                              :rem 33
955 POKEF+4,129:FORC=0TO90STEP1.5:POKEF+1
    ,C:NEXT:POKEF+4,17:POKEA+40,32:rem 75
960 A=A+2:HU$=HU$+CHR${8+64):IFA<1405THEN
    943                                 :rem 231
962 PRINT"{4 DOWN}":POKEF+4,0:POKE51457,1
    14                                  :rem 81
965 GOSUB590:PRINT"{HOME}":FORA=1TO13
                                        :rem 183
970 PRINT"{32 SPACES}":NEXT:GOTO90
                                        :rem 198
990 PRINT"{HOME}{2 DOWN}{RIGHT}U*********
    ********************I"SPC(9)"8"SPC(29
    )"B"                                :rem 65
995 PRINT"{RIGHT}J************************
    ******K{HOME}{3 DOWN}{2 RIGHT}";:RETU
    RN                                  :rem 191
```

The player just missed a light bulb in the 64 version of "Lightsaver."

Program 2: VIC Lightsaver/MLX

Be sure to read the "Tiny MLX" article before typing.

Version by Gregg Peele, Assistant Programming Supervisor

Refer ta the "Automatic Proofreader" article before typing this program in.

```
6430 :011,016,000,000,158,052,011
6436 :049,048,057,000,000,000,190
6442 :169,000,141,092,003,141,076
6448 :093,003,169,024,141,015,237
6454 :144,032,078,020,032,100,204
6460 :016,032,236,017,032,042,179
6466 :017,169,007,141,074,003,221
6472 :169,003,141,064,003,173,113
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6478 :076,003,016,024,032,203,176
6484 :017,172,074,003,196,251,029
6490 :208,003,076,077,016,032,246
6496 :015,019,032,246,018,169,083
6502 :010,141,076,003,206,076,102
6508 :003,032,108,017,032,125,169
6514 :016,032,038,019,032,179,174
6520 :019,173,072,003,208,207,034
6526 :076,205,018,169,000,141,223
6532 :060,003,141,061,003,141,029
6538 :074,003,032,042,017,169,219
6544 :003,141,072,003,169,010,030
6550 :141,076,003,096,169,000,123
6556 :141,019,145,169,127,141,130
6562 :034,145,173,008,144,074,228
6568 :074,074,074,073,015,056,022
6574 :233,003,016,002,169,000,085
6580 :141,064,003,168,162,002,208
6586 :185,162,031,208,008,169,181
6592 :032,153,162,031,032,023,113
6598 :017,185,184,031,208,008,063
6604 :169,032,153,184,031,032,037
6610 :023,017,185,206,031,208,112
6616 :008,169,032,153,206,031,047
6622 :032,023,017,200,202,016,200
6628 :213,172,064,003,196,252,104
6634 :240,071,164,252,169,032,138
6640 :162,003,153,184,031,153,158
6646 :206,031,200,202,016,246,123
6652 :172,064,003,169,027,153,072
6658 :184,031,153,206,031,132,227
6664 :252,169,000,153,184,151,149
6670 :153,206,151,200,169,028,153
6676 :153,184,031,153,206,031,010
6682 :169,000,153,184,151,153,068
6688 :206,151,200,169,029,153,172
6694 :184,031,153,206,031,169,044
6700 :000,153,184,151,153,206,123
6706 :151,096,173,082,003,240,027
6712 :003,206,082,003,238,060,136
6718 :003,173,060,003,208,003,000
6724 :238,061,003,162,004,160,184
6730 :016,024,032,240,255,174,047
6736 :060,003,173,061,003,032,156
6742 :205,221,056,173,060,003,036
6748 :237,092,003,133,170,173,132
6754 :061,003,237,093,003,005,244
6760 :170,144,012,173,060,003,154
6766 :141,092,003,173,061,003,071
6772 :141,093,003,162,008,160,171
6778 :016,024,032,240,255,174,095
6784 :092,003,173,093,003,032,012
6790 :205,221,096,169,206,133,140
6796 :167,169,031,133,168,173,213
6802 :141,002,208,251,169,228,121
6808 :133,170,169,031,133,171,191
6814 :169,228,133,180,169,151,164
6820 :133,181,162,021,160,021,074
6826 :177,167,208,012,072,169,207
6832 :032,145,167,104,145,170,171
6838 :169,000,145,180,136,016,060
6844 :237,056,165,167,233,022,044
6850 :133,167,165,168,233,000,036
6856 :133,168,056,165,170,233,101
6862 :022,133,170,165,171,233,076
6868 :000,133,171,056,165,180,149
6874 :233,022,133,180,165,181,108
6880 :233,000,133,181,202,016,221
6886 :193,096,032,148,224,165,064
6892 :142,162,003,010,202,208,195
6898 :252,024,101,142,010,101,104
6904 :142,105,003,133,142,074,079
6910 :074,056,233,012,176,252,033
6916 :105,015,133,251,096,169,005
6922 :128,141,019,145,169,255,099
6928 :141,034,145,169,147,032,172
6934 :210,255,162,011,160,005,057
6940 :024,032,240,255,160,000,227
6946 :185,193,019,032,210,255,160
6952 :200,192,012,208,245,169,042
6958 :014,032,210,255,162,013,220
6964 :160,005,024,032,240,255,000
6970 :160,000,185,205,019,032,147
6976 :210,255,200,192,012,208,117
6982 :245,032,228,255,240,251,041
6988 :201,049,144,247,201,054,204
6994 :176,243,056,233,048,073,143
7000 :255,141,063,003,169,147,098
7006 :032,210,255,174,063,003,063
7012 :024,169,000,105,048,202,136
7018 :208,251,141,082,003,162,185
7024 :003,160,016,024,032,240,075
7030 :255,160,000,185,010,020,236
7036 :032,210,255,200,192,007,252
7042 :208,245,162,006,160,016,159
7048 :024,032,240,255,160,000,079
7054 :185,017,020,032,210,255,093
7060 :200,192,012,208,245,162,143
7066 :010,160,016,024,032,240,124
7072 :255,160,000,185,029,020,041
7078 :032,210,255,200,192,007,038
7084 :208,245,162,013,160,016,208
7090 :024,032,240,255,160,000,121
7096 :185,036,020,032,210,255,154
7102 :200,192,015,208,245,162,188
7108 :022,160,001,024,032,240,163
7114 :255,160,000,185,059,020,113
7120 :032,210,255,200,192,019,092
7126 :208,245,173,017,145,041,019
7132 :016,208,249,160,021,169,019
7138 :032,153,228,031,136,208,246
7144 :248,096,160,002,162,022,154
7150 :024,032,240,255,160,000,181
7156 :185,217,019,032,210,255,138
7162 :200,192,018,208,245,032,121
7168 :228,255,240,251,201,089,240
7174 :240,007,201,078,240,006,010
7180 :076,226,018,076,029,016,197
7186 :000,164,251,140,074,003,138
7192 :162,001,024,032,240,255,226
7198 :160,000,185,235,019,032,149
7204 :210,255,200,192,016,208,093
7210 :245,096,172,074,003,162,026
7216 :001,024,032,240,255,160,248
7222 :000,185,251,019,032,210,239
7228 :255,200,192,014,208,245,150
7234 :096,160,021,185,228,031,019
7240 :208,028,169,036,153,228,126
7246 :031,169,000,153,228,151,042
7252 :072,152,072,032,142,019,061
7258 :032,179,019,104,168,104,184
7264 :206,072,003,076,076,019,036
7270 :136,208,220,169,032,153,252
7276 :228,031,162,011,160,016,204
7282 :024,032,240,255,173,082,152
7288 :003,205,084,003,240,013,156
7294 :160,000,185,051,020,032,062
7300 :210,255,200,192,008,208,181
7306 :245,173,082,003,141,084,098
7312 :003,056,073,255,170,169,102
7318 :000,032,205,221,162,015,017
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7324 :160,016,024,032,240,255,115
7330 :174,072,003,169,000,032,100
7336 :205,221,096,169,015,141,247
7342 :014,144,169,129,141,013,016
7348 :144,162,010,138,072,032,226
7354 :179,019,104,170,202,208,044
7360 :246,169,000,141,014,144,138
7366 :024,173,082,003,105,016,089
7372 :141,082,003,096,172,082,012
7378 :003,162,080,202,208,253,094
7384 :136,192,255,208,246,096,069
7390 :144,076,073,071,072,084,230
7396 :083,065,086,069,082,032,133
7402 :076,069,086,069,076,032,130
7408 :040,049,045,053,041,063,019
7414 :080,076,065,089,032,065,141
7420 :071,065,073,078,032,089,148
7426 :032,079,082,032,078,063,112
7432 :031,094,157,017,094,157,046
7438 :157,017,095,033,035,017,112
7444 :157,157,144,064,144,032,206
7450 :157,017,032,157,157,017,051
7456 :032,032,032,017,157,157,203
7462 :017,028,083,067,079,082,138
7468 :069,144,030,072,073,017,193
7474 :157,157,083,067,079,082,163
7480 :069,144,156,083,080,069,145
7486 :069,068,144,066,085,076,058
7492 :066,083,017,157,157,157,193
7498 :157,157,076,069,070,084,175
7504 :032,032,032,032,157,157,010
7510 :157,157,080,082,069,083,202
7516 :083,032,070,073,082,069,245
7522 :032,084,079,032,083,084,236
7528 :065,082,084,160,000,185,168
7534 :000,128,153,000,028,200,107
7540 :208,247,160,000,185,000,148
7546 :129,153,000,029,200,208,073
7552 :247,160,007,185,150,020,129
7558 :153,000,028,136,016,247,202
7564 :160,039,185,158,020,153,087
7570 :216,028,136,016,247,160,181
7576 :007,185,198,020,153,008,211
7582 :029,136,016,247,160,015,249
7588 :185,206,020,153,024,029,013
7594 :136,016,247,169,255,141,110
7600 :005,144,096,024,024,024,237
7606 :036,066,066,102,060,000,000
7612 :000,234,117,058,029,014,128
7618 :007,000,000,170,085,170,114
7624 :085,170,255,000,000,175,117
7630 :094,188,120,240,224,024,072
7636 :024,024,024,024,024,024,100
7642 :024,000,001,003,007,015,012
7648 :031,063,127,255,255,255,186
7654 :255,255,255,255,255,000,225
7660 :128,192,224,240,248,252,240
7666 :254,000,024,024,060,086,178
7672 :203,000,000,000,000,000,195
```

Program 3: Atari Data Loader

Refer to the "Automatic Proofreader" article before typing this program in.

```
DM 1000 X=0:Y=0:? "{CLEAR}LOADING CH
        ARACTER SET"
DM 1010 POKE 752,1
LM 1020 CHSET=14336:FOR I=0 TO 511:P
        OKE CHSET+I,PEEK(57344+I):NE
        XT I
MM 1025 RESTORE 1045:? "REDEFINING C
        HARACTER SET"
GB 1030 READ A:IF A=-1 THEN POKE 756
        ,CHSET/256:GOTO 1041
CM 1035 FOR J=0 TO 7:READ B:POKE CHS
        ET+A*8+J,B:NEXT J
MC 1040 GOTO 1030
CJ 1041 ? "LOADING ML PROGRAM 1"
MC 1042 READ A:IF A=-1 THEN 1045
GJ 1043 POKE 1536+X,A:X=X+1
MJ 1044 GOTO 1042
CD 1045 ? "LOADING ML PROGRAM 2"
ID 1046 READ A:IF A=-1 THEN ? "RUNNI
        NG LIGHTSAVER":RUN "D:LIGHTS
        AVER"
MA 1047 POKE 13470+Y,A:Y=Y+1
NB 1048 GOTO 1046
CM 1050 DATA 16,126,103,103,103,103,
        103,127,63
IC 1060 DATA 17,28,60,124,28,28,28,1
        27,127
AF 1070 DATA 18,126,103,7,127,112,11
        5,115,127
EI 1080 DATA 19,126,103,7,63,7,103,1
        27,63
OC 1090 DATA 20,6,15,27,51,127,127,7
        ,15
KC 1100 DATA 21,126,96,126,103,7,103
        ,127,63
AB 1110 DATA 22,126,103,96,126,103,1
        03,127,63
BF 1130 DATA 23,126,103,7,14,28,28,2
        8,28
CM 1140 DATA 24,126,103,103,127,103,
        103,127,63
NB 1150 DATA 25,126,103,103,127,7,10
        3,127,63
AB 1190 DATA 1,2,11,14,10,11,14,5,5
NG 1191 DATA 2,128,224,160,240,160,1
        60,80,80
IM 1192 DATA 3,21,85,85,85,85,21,21,
        5
DM 1193 DATA 4,84,85,117,245,117,84,
        84,80,-1
CN 1536 DATA 173,36,2,141,51,6
CM 1542 DATA 173,37,2,141,52,6
JL 1548 DATA 169,0,141,205,6,169
DB 1554 DATA 7,162,6,160,28,32
AA 1560 DATA 92,228,104,96,173,152
ML 1566 DATA 52,240,17,173,156,52
CM 1572 DATA 141,206,6,32,53,6
JK 1578 DATA 206,206,6,173,206,6
DK 1584 DATA 208,245,76,255,255,206
GB 1590 DATA 205,6,173,205,6,16
GI 1596 DATA 12,169,7,141,205,6
CC 1602 DATA 141,5,212,32,80,6
GM 1608 DATA 96,173,205,6,141,5
MD 1614 DATA 212,96,165,88,24,105
JF 1620 DATA 72,141,121,6,165,89
FF 1626 DATA 105,3,141,122,6,24
LM 1632 DATA 173,121,6,105,40,141
JB 1638 DATA 124,6,133,5,173,122
CF 1644 DATA 6,105,0,141,125,6
JR 1650 DATA 133,6,162,15,160,39
GP 1656 DATA 185,255,255,153,255,255
PN 1662 DATA 136,16,247,56,173,121
GA 1668 DATA 6,141,124,6,233,40
ID 1674 DATA 141,121,6,173,122,6
IM 1680 DATA 141,125,6,233,0,141
MG 1686 DATA 122,6,202,208,219,24
```

```
JN 1692 DATA 173,124,6,141,173,6
JP 1698 DATA 173,125,6,141,174,6
MK 1704 DATA 169,0,160,39,153,255
OO 1710 DATA 255,136,16,250,160,40
JD 1716 DATA 136,177,5,208,5,192
GA 1722 DATA 0,208,247,96,201,5
PM 1728 DATA 176,242,169,0,141,152
JD 1734 DATA 52,169,1,141,153,52
MP 1740 DATA 96,-1
PJ 13470 DATA 169,80,141,3,210,169
MG 13476 DATA 1,141,152,52,165,45
FE 13482 DATA 141,143,52,169,100,141
PP 13488 DATA 144,52,169,0,141,146
CB 13494 DATA 52,141,151,52,141,145
PI 13500 DATA 52,141,153,52,165,88
CE 13506 DATA 24,105,24,133,208,165
PI 13512 DATA 89,105,1,133,209,165
MC 13518 DATA 88,24,105,121,133,3
JF 13524 DATA 165,89,105,2,133,4
FG 13530 DATA 172,154,52,162,255,202
CI 13536 DATA 224,0,208,251,136,192
MF 13542 DATA 0,208,246,173,5,208
IG 13548 DATA 201,0,240,6,32,106
MM 13554 DATA 54,32,54,54,174,143
PC 13560 DATA 52,236,144,52,240,14
BM 13566 DATA 144,2,202,202,232,142
MF 13572 DATA 143,52,142,0,208,76
GM 13578 DATA 199,53,160,120,136,177
MF 13584 DATA 208,201,0,208,7,192
JK 13590 DATA 0,208,245,76,35,53
AG 13596 DATA 201,5,176,238,76,134
CM 13602 DATA 53,172,145,52,204,147
PK 13608 DATA 52,16,222,238,145,52
CF 13614 DATA 169,172,141,1,210,165
MF 13620 DATA 67,141,3,210,169,55
BM 13626 DATA 141,2,210,169,120,141
LM 13632 DATA 0,210,173,143,52,56
BC 13638 DATA 233,46,74,74,168,169
MB 13644 DATA 1,145,208,169,2,200
CJ 13650 DATA 145,208,152,24,105,39
DD 13656 DATA 168,169,3,145,208,200
NA 13662 DATA 169,4,145,208,173,5
IM 13668 DATA 208,201,0,240,6,32
MO 13674 DATA 106,54,32,54,54,165
LM 13680 DATA 20,105,2,24,141,149
AE 13686 DATA 52,166,20,236,149,52
ML 13692 DATA 208,249,169,0,141,1
DM 13698 DATA 210,141,3,210,173,10
PM 13704 DATA 210,109,148,52,74,74
EI 13710 DATA 170,173,10,210,205,143
JG 13716 DATA 52,144,13,208,3,76
CK 13722 DATA 134,53,138,24,109,144
AG 13728 DATA 52,76,175,53,138,141
AD 13734 DATA 149,52,173,144,52,56
CL 13740 DATA 237,149,52,201,54,144
JB 13746 DATA 211,201,198,176,207,14
         1
PF 13752 DATA 144,52,173,5,208,201
FP 13758 DATA 0,240,6,32,106,54
JM 13764 DATA 32,54,54,173,5,208
ID 13770 DATA 201,0,240,6,32,106
MM 13776 DATA 54,32,54,54,173,112
MF 13782 DATA 2,73,255,201,42,144
CD 13788 DATA 10,201,196,176,14,141
MI 13794 DATA 1,208,76,244,53,169
MF 13800 DATA 47,141,1,208,76,244
PM 13806 DATA 53,169,192,141,1,208
PC 13812 DATA 141,150,52,173,5,208
IG 13818 DATA 201,0,240,6,32,106
ML 13824 DATA 54,32,54,54,173,152
LK 13830 DATA 52,201,0,240,38,172
CP 13836 DATA 145,52,204,147,52,208
LK 13842 DATA 32,173,151,52,201,1
CM 13848 DATA 240,11,238,151,52,165
BP 13854 DATA 20,24,105,140,141,146
PG 13860 DATA 52,165,20,205,146,52
DB 13866 DATA 208,155,169,0,141,152
MF 13872 DATA 52,104,96,76,218,52
GI 13878 DATA 165,1,166,0,32,62
DA 13884 DATA 54,96,134,212,133,213
CF 13890 DATA 32,170,217,32,230,216
MI 13896 DATA 160,0,132,2,177,243
JM 13902 DATA 72,41,127,32,93,54
JA 13908 DATA 104,48,5,164,2,200
DJ 13914 DATA 208,238,96,170,173,71
CP 13920 DATA 3,72,173,70,3,72
AI 13926 DATA 138,160,146,96,169,0
CD 13932 DATA 141,30,208,141,155,52
KI 13938 DATA 169,6,133,85,169,0
MK 13944 DATA 133,84,165,0,24,109
JA 13950 DATA 148,52,133,0,165,1
LN 13956 DATA 105,0,133,1,173,150
JE 13962 DATA 52,162,0,56,233,42
AJ 13968 DATA 74,74,24,105,160,168
AI 13974 DATA 169,0,141,149,52,177
IE 13980 DATA 3,201,1,240,45,201
IM 13986 DATA 2,240,61,201,3,240
NF 13992 DATA 77,201,4,240,93,169
MC 13998 DATA 0,145,3,200,232,224
OP 14004 DATA 13,144,228,162,1,238
CE 14010 DATA 149,52,173,149,52,201
LJ 14016 DATA 5,240,10,152,56,233
MN 14022 DATA 52,168,169,0,76,155
GK 14028 DATA 54,96,169,0,145,3
OF 14034 DATA 200,145,3,152,24,105
JA 14040 DATA 39,152,169,0,145,3
JD 14046 DATA 200,145,3,96,169,0
LO 14052 DATA 145,3,136,145,3,152
MH 14058 DATA 24,105,40,168,169,0
JA 14064 DATA 145,3,200,145,3,96
LL 14070 DATA 169,0,145,3,200,145
MJ 14076 DATA 3,152,56,233,40,168
MG 14082 DATA 169,0,145,3,136,145
DK 14088 DATA 3,96,169,0,145,3
PK 14094 DATA 136,145,3,152,56,233
IM 14100 DATA 40,168,169,0,145,3
PC 14106 DATA 200,145,3,96,-1
```

Program 4: Atari Lightsaver

Version by Chris Poer, Editorial Programmer

Refer to the "Automatic Proofreader" article before typing this program in.

```
DL 2 POKE 13464,0:POKE 106,64:GRAPHI
     CS 0:OPEN #1,4,0,"K:":HIGH=0:Q=
     USR(1536):DIM A$(3),B$(1)
HK 5 GOSUB 700:GRAPHICS 0:GOSUB 800:
     B$=" "
KG 10 PUT #6,125:POKE 82,0
KB 13 POKE 752,1:SETCOLOR 2,0,0:GOSU
      B 600:POKE 87,0
PB 15 BULB=13459:MEN=3:LEV=13460:SC=
      0
IF 20 POKE BULB,20:POKE LEV,1:EX=200
      0:XX=0:AM=20
DG 100 IF SC>HIGH THEN HIGH=SC
KL 110 GOSUB 900
GM 130 Q=USR(13470)
KL 135 SC=PEEK(0)+PEEK(1)*256
```

```
DL 137 IF SC>EX THEN EX=EX+2000:MEN=
       MEN+1:FOR I=1 TO 100:SOUND 0,
       INT(RND(1)*255),10,14:NEXT I:
       SOUND 0,0,0,0
EP 140 IF PEEK(13465)=1 THEN GOSUB 5
       00
JH 145 IF XX=1 THEN XX=0:GOTO 100
KC 150 SOUND 0,140,10,12:FOR I=1 TO
       120:NEXT I:SOUND 0,90,10,14
AJ 160 FOR I=1 TO 80:NEXT I:SOUND 0,
       0,0,0
JE 180 POKE LEV,PEEK(LEV)+1
PJ 190 AM=AM+4:POKE BULB,AM+4
KI 200 POKE 1346B,INT(PEEK(LEV)/5)+1
       :IF INT(PEEK(LEV)/5)+1=7 THEN
        POKE 1346B,6
FH 210 GOTO 100
DA 500 SOUND 0,200,12,14:FOR I=1 TO
       80:NEXT I:SOUND 0,0,0,0:XX=1
CB 505 IF PEEK(LEV)>1 THEN POKE LEV,
       PEEK(LEV)-1
ND 510 MEN=MEN-1:IF MEN=0 THEN 850
CH 515 POKE BULB,AM:IF INT(PEEK(LEV)
       /5)+1<7 THEN POKE 13468,INT(P
       EEK(LEV)/5)+1
HK 550 RETURN
DJ 600 A=56:POKE 54279,A:PMBASE=256*
       A:POKE 756,56
BJ 615 POKE 0,0:POKE 1,0:POKE 1346B,
       1
GD 627 POKE 53249,90:POKE 5324B,90
HM 630 FOR I=PMBASE+512 TO PMBASE+76
       B:POKE I,0:NEXT I
PE 640 POKE 704,216:POKE 705,11B
CD 650 RESTORE 670:FOR I=PMBASE+550+
       Y TO PMBASE+562+Y:READ A:POKE
        I,A:NEXT I
DB 660 FOR I=PMBASE+739+Y TO PMBASE+
       750+Y:READ A:POKE I,A:NEXT I
FD 670 DATA 24,24,24,24,24,24,24,24,
       24,24,60,126,255
EB 680 DATA 255,255,255,255,255,255,
       126,126,126,60,60,60
HH 690 POKE 53256,1:POKE 53257,1:POK
       E 623,1:RETURN
HN 700 GRAPHICS 18:POSITION 4,3:? #6
       ;"LiGHTsaVEr"
PI 710 FOR I=1 TO 120:X=INT(RND(1)*2
       55):SOUND 0,X,10,12:NEXT I
HC 720 SOUND 0,80,10,14:FOR I=1 TO 1
       00:NEXT I
LK 730 SOUND 0,0,0,0:GRAPHICS 18:POK
       E 53248,220:POKE 53249,220
JD 740 POSITION 1,4:? #6;"enter leve
       l of play"
PK 750 POSITION 3,6:? #6;"(#%9)  (H
       REST"
PD 760 GET #1,DIF:IF DIF>57 OR DIF<4
       9 THEN 750
PB 770 DIF=(DIF-48):POKE 13466,DIF:R
       ETURN
NJ 800 DL=PEEK(560)+4+PEEK(561)*256
PA 801 FOR I=2 TO 6:POKE DL+I,6:NEXT
        I:POKE DL-1,6+64
FJ 810 FOR I=7 TO 24:POKE DL+I,36:NE
       XT I:POKE 87,1:RETURN
JE 850 IF PEEK(0)+PEEK(1)*256>HIGH T
       HEN HIGH=PEEK(0)+PEEK(1)*256
HH 855 POKE 53248,220:POKE 53249,220
HC 860 POKE 53277,0:POSITION 1,2:? #
       6;"(E) TO END PROGRAM  (P) TO
        PLAY AGAIN"
DH 870 GET #1,W:IF W=69 THEN Q=USR(5
       B4B4)
DG 880 IF W<>80 THEN 870
JJ 890 GOSUB 700:GRAPHICS 0:GOSUB 80
       0:GOTO 10
DI 900 POSITION 0,0:? #6;"SCORE ";SC
ED 910 A$=STR$(PEEK(LEV)):IF PEEK(LE
       V)<10 THEN A$(LEN(A$)+1)=B$
CN 920 POSITION 0,1:? #6;"HI SCORE "
       ;HIGH:POSITION 12,0:? #6;"LEV
       EL ";A$
HP 930 POSITION 15,1:? #6;"MEN ";MEN
       :POKE 5324B,220:POKE 53249,22
       0
ID 940 POKE 53277,0:FOR I=1 TO 200:P
       OKE 13464,1:NEXT I:POKE 13464
       ,0
EN 950 POSITION 0,2:? #6;" hit paddl
       e button{3 SPACES}to begin ro
       und"
HB 960 IF PTRIG(0)=1 THEN 960
PE 970 POSITION 0,2:? #6;"
       {35 SPACES}"
CG 980 POKE 559,46:POKE 53277,3:POKE
        77,0:RETURN
```

Program 5: IBM PC/PCjr Lightsaver

Version by Tim Victor, Editorial Progrommer

```
5 CLEAR ,&H0000
10 ON ERROR GOTO 20000:GOSUB B000
65 NP=100:DF=15:LEVEL=1:MISSES=0
68 SC=0:C=0
70 CLS:GOSUB 4000
80 BP=JSF*(STICK(0)-3)
100 CALL BLANK:PUT (BP,183),C%
110 LP=80:PUT (LP,0),L%
114 FOR X%=0 TO 6:XP(X%)=0:NEXT
115 GOSUB 5000
120 X%=5:CF=1:Z=STRIG(0)
130 BNUM=INT(10*RND(1))+10:BN=1
135 GOSUB 2000:IF CF=0 THEN 310
137 GOSUB 3000
138 IF BN<BNUM THEN GOSUB 1000 ELSE XP(X
%)=0:X%=FNDEC(X%)
139 IF BN<BNUM+5 THEN BN=BN+1:X%=FNDEC(X
%):GOTO 135
140 DF=DF*1.1:GOTO 114
310 PUT (BB,153),B%:PUT (BB,185),B%
320 FOR I=1 TO 20:SOUND 2000,.2:SOUND 32
767,.2:NEXT
325 DF=DF/1.1:MISSES=MISSES+1
330 IF MISSES=4 THEN GOSUB 6000:GOTO 65
340 GOSUB 7000:GOTO 70
999 'move lamp and make new bulb
1000 NP=NP+4*INT(DF*(RND(1)-.479))
1010 IF NP>200 THEN NP=200
1020 IF NP<0 THEN NP=0
1030 CALL BLANK:PUT (LP,0),L%:PUT (NP,0)
,L%:LP=NP
1040 XP(X%)=NP+12:PUT (XP(X%),28),B%
1045 SOUND 37,.1
1050 X%=FNDEC(X%)
1060 RETURN
1999 'is bulb about to break?
2000 BB=XP(X%)
2010 IF BB<>0 AND (BB<BP-3 OR BB>BP+26)
THEN CF=0:RETURN
```

```
2020 IF 88 THEN PUT (88,178),8%:C=C+1:SO
UND 2000,.1
2025 IF STRIG(0) THEN GOSUB 7000:WHILE S
TRIG(1):WEND:Z=STRIG(0)
2030 RETURN
2999 'drop all bulbs
3000 FOR I%=153 TO 23 STEP -25
3010 XP=XP(X%)
3020 IF XP THEN PUT (XP,I%),8%:PUT (XP,I
%+25),8%
3030 N8P=JSF*(STICK(0)-3)
3040 CALL BLANK:PUT (BP,183),C%:PUT (N8P
,183),C%:BP=N8P
3050 X%=FNDEC(X%):NEXT
3060 RETURN
3999 'draw scoreboard
4000 LINE (0,0)-(240,199),3,B
4005 LINE (240,0)-(319,199),1,B
4006 LINE (242,2)-(317,45),1,B
4007 LINE (242,47)-(317,86),1,B
4008 LINE (242,88)-(317,127),1,B
4009 LINE (242,129)-(317,168),1,B
4010 LOCATE 3,33:PRINT "LEVEL:"
4020 LOCATE 8,33:PRINT "SCORE:"
4030 LOCATE 13,33:PRINT "HIGH:"
4040 LOCATE 18,33:PRINT "BROKEN:"
4300 RETURN
4999 'update score
5000 SC=SC+C*LEVEL:C=0
5005 IF CF=0 THEN LEVEL=LEVEL-1 ELSE LEV
EL=LEVEL+1
5006 IF LEVEL=0 THEN LEVEL=1
5010 LOCATE 5,34:PRINT LEVEL
5020 LOCATE 10,34:PRINT FNFMT$(STR$(SC))
5025 LOCATE 15,34:PRINT FNFMT$(STR$(HI))
5030 LOCATE 20,34:PRINT MISSES
5200 RETURN
5999 'end of game
6000 LOCATE 20,12:PRINT "PRESS TRIGGER F
OR ANOTHER GAME"
6005 GOSUB 5000
6010 WHILE STRIG(1)=0:WEND
6020 IF SC>HI THEN HI=SC
6030 RETURN
6999 'wait for button press
7000 LOCATE 23,33:PRINT "PRESS";
7010 LOCATE 24,33:PRINT "BUTTON";
7020 WHILE STRIG(1)=0:IF INKEY$="e" OR I
NKEY$="E" THEN END
7030 WEND
7040 LINE (256,176)-(318,191),0,BF
7050 RETURN
7999 'initialize graphics
8000 SCREEN 1:COLOR 0,1:KEY OFF:CLS
8005 STRIG ON:RANDOMIZE TIMER
8010 DIM B%(25),C%(47),L%(119)
8020 DEF FNDEC(X%)=X%-1-7*(X%=0)
8030 DEF FNFMT$(A$)=LEFT$("0000",5-LEN(A
$))+RIGHT$(A$,LEN(A$)-1)
8040 BLANK=&HD000
8050 FOR I=BLANK TO BLANK+9:READ A
8060 POKE I,A:NEXT
8100 DRAW "bm117,10c2ta45d20ta0134"
8105 DRAW "ta-45u20bm117,15p2,2"
8110 LINE (116,0)-(118,11),3,BF
8115 LINE (100,24)-(134,25),3,BF
8120 GET (100,0)-(134,25),L%
8125 LOCATE 11,6:PRINT "THIS IS NO ORDIN
ARY LAMP."
8130 PRINT "ANGERED BY ITS BORING AND ME
NIAL JOB,"
8135 FOR I=1 TO 600:NEXT
8140 LINE (115,31)-(119,40),3,BF
8145 LINE (112,36)-(122,38),3,BF
8150 LINE (115,28)-(119,30),1,BF
8155 LINE (114,34)-(120,34),3
8160 LINE (113,35)-(121,35),3
8165 LINE (113,39)-(121,39),3
8170 PRESET (115,28):PRESET (119,28)
8175 LINE (117,38)-(119,38),1
8180 LINE (119,37)-(120,37),1
8185 PSET (120,36),1
8187 GET (112,28)-(122,40),B%
8190 LOCATE 14,4:PRINT "IT IS DROPPING F
RAGILE, HELPLESS"
8195 PRINT "LIGHTBULBS TO THEIR CERTAIN
DESTRUCTION."
8200 DRAW "C3BM103,183TA30D10TA0L12"
8205 DRAW "TA-30U10BM103,187P3,3"
8210 GET (97,183)-(109,192),C%
8215 PUT (97,183),C%,PRESET
8220 GET (97,183)-(109,192),C%
8225 FOR J=30 TO 63 STEP 4
8230 LINE (J,182)-(J+10,192)
8235 LINE (J,182)-(J-10,192)
8240 NEXT
8245 LINE (30,182)-(63,182),0
8250 LINE (30,183)-(63,183),3
8255 LINE (30,192)-(63,192),3
8260 DRAW "BM30,183TA30D10"
8265 DRAW "BM63,183TA-30D10"
8270 PUT (23,183),C%,AND
8275 PUT (58,183),C%,AND
8280 GET (30,183)-(63,192),C%
8285 LINE (0,182)-(120,192),0,BF
8290 LOCATE 17,1:PRINT "USING YOUR BASKE
T, YOU MUST SAVE THE"
8295 PRINT "BULBS FROM THIS PSYCHOPATHIC
 APPLIANCE."
8300 BP=2*(STICK(0)-3)
8305 IF BP>210 THEN BP=210
8310 CALL BLANK:PUT (BP,183),C%
8400 LOCATE 20,1:PRINT "TO BEGIN, MOVE T
HE BASKET ALL THE WAY"
8410 LOCATE 21,3:PRINT "TO THE RIGHT AND
 PRESS THE BUTTON."
8420 WHILE STRIG(1)=0
8425 N8P=2*(STICK(0)-3)
8430 IF N8P>210 THEN N8P=210
8432 CALL BLANK:PUT (BP,183),C%:PUT (N8P
,183),C%:BP=N8P:WEND
8435 JSF=210/(STICK(0)-3)
8440 RETURN
10000 DATA 186,218,3,237,37
10010 DATA 8,0,116,250,203
20000 IF (ERR=5 OR ERR=6) AND (ERL=3040
OR ERL=100) THEN BP=210:PUT (BP,183),C%
ELSE ON ERROR GOTO 0
20010 RESUME NEXT
```


COMPUTE!
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Build A Computer In Your Mind

Fred D'Ignazio, Associate Editor

In my recent column, "The Morning After," in the May and June 1984 issues of COMPUTE!, I wrote about a new kind of programming that I believe people are beginning to do on their computer. I called this "neoprogramming" to distinguish it from traditional programming in BASIC or Pascal and from "no programming" in which people treat the computer as a thinking machine and let it do their thinking for them.

In this month's column I'd like to explore neoprogramming and see how it can be related to computer activities that will help people develop thinking, learning, and communication skills that they can practice and refine using the computer, and that they can also take away from the computer and use, on their own, in all areas of their lives.

Neoprogramming

Neoprogramming can be defined as borrowing the most powerful ideas from programming languages and turning them into thinking skills that people can use, inside their head, in their daily life.

Another way to look at neoprogramming is as a toolbox that has three kinds of tools inside:

- ☐ Tools to Help You Think
- ☐ Tools to Help You Learn
- ☐ Tools to Help You Communicate

These are practical tools that will be valuable no matter what people's goals are. Mastering these tools is more worthwhile than simply learning how to operate a computer.

Thinking, learning, and communication tools can be found in many places—in textbooks, in courses, in jobs, etc. But they can also be found, in a concentrated form, in the computer. And through extensive use and familiarity with these tools on a computer, people can learn how to use the tools to think better without the computer.

How Not To Use A Computer

Learning how to operate a computer, on its own, will not automatically guarantee people a successful career, help them learn how to use more advanced computers of the future, or give them thinking skills they can apply to other areas of their lives.

Also, it is possible to have a relationship with computers that actually deadens or stifles the ability to think. Many people, for example, use computers mechanically and passively. They spend their time in front of a computer entering information, making trivial, routine queries, or typing other people's documents.

The Thinking Appliance

There is a strong assumption in many people's minds that computers are labor-saving appliances. People ask, "What can I do on a computer?" But what they mean is, "What can the computer do for me?" The labor that many people hope computers will save is not mechanical labor but thinking labor. For most of us, thinking is work—work that we would avoid if we had the chance.

Many people would be happy (though few would admit it) if computers would do their thinking for them. In the near future, with the

Fred D'Ignazio is a computer enthusiast and author of several books on computers for young people. His books include Katie and the Computer *(Creative Computing),* Chip Mitchell: The Case of the Stolen Computer Brains *(Dutton/Lodestar),* The Star Wars Question and Answer Book About Computers *(Random House), and* How To Get Intimate With Your Computer (A 10-Step Plan To Conquer Computer Anxiety) *(McGraw-Hill).*

As the father of two young children, Fred has become concerned with introducing the computer to children as a wonderful tool rather than as a forbidding electronic device. His column appears monthly in COMPUTE!.

advent of expert systems and friendlier computers, there is a great risk that computers will take over more and more of the thinking that people do. As a result, people and organizations will become increasingly dependent on computers.

Dumbo's Feather

For adults at work and at home, and for children in school, there is the risk that computers will become super calculators. When they want to do real work or thinking, they will, by habit, turn to the computer. The computer will become an adjunct to the person's mind. The computer will be like Dumbo's feather. Dumbo the elephant could fly because of his big ears, but he thought it was because of his magic feather. If he didn't hold on tight to his feather, he was afraid he couldn't fly. People may come to feel incapable of thought unless they do it using their computer.

The Computer Crutch

There is a real risk that many people will use computers as a crutch. They will expect computers to do their thinking for them, or they will be afraid that they cannot think without the aid of the computer. Either way, they will be tied to computers to help them carry on their daily affairs.

Also, if people use computers (or anticipate using computers) as a crutch, they will not get the most out of them. They will be using computers' powerful computational, communications, and information handling functions sloppily, indiscriminately, and inefficiently.

The Computer Lever

In fact, the computer is not a thinking machine, a magic feather, or a crutch. It is a complex lever. It amplifies our abilities to move information around, but we must position and guide it to get what we want.

In addition, we don't need to tie ourselves to the computer to use its lever. We can build the lever inside our head. The lever is, in fact, just an assortment of thinking skills embedded in general-purpose (BASIC, Logo, Pascal, Assembler, etc.) *procedural* languages and special-purpose (word processing, spreadsheet, file handling) *builder kit* languages. Once we have acquired these skills, we can employ them on the computer, or we can use them inside our heads. If we recognize and master these skills, we can get more out of using the computer, and we can become less dependent on it and more skilled, on our own, to think, learn, and communicate.

Building A Computer Inside Your Head

Burrell Smith, Apple's hardware wizard who helped create the Macintosh, has written that he never just goes into a workshop and builds a new computer. Instead he first spends considerable time building mental prototypes inside his head. Burrell's prototypes are like a writer's rough drafts. Using mental prototypes, he takes a rough, simple idea and turns it into a cluster of complex ideas, and eventually into an advanced concept or design. Then he begins building the computer.

Burrell can create mental prototypes because he has a computer inside his head. Burrell has built this computer from an array of thinking skills he has learned from programming real computers and from his other experiences in life. These skills aren't mysterious, nor are they Burrell's alone. They can be mastered by anyone.

Environments For Thinking

Programming languages offer an environment for thinking—a place in which these skills can be learned, practiced, mastered, and then used. Learning a programming language offers an opportunity to explore new avenues of thought.

For example, if taught properly, BASIC, Pascal, Logo, and other languages can help people learn algorithmic thinking, how to break complex problems into smaller, simpler problems, and how to organize large quantities of information.

A word processing program can give people a feeling for the fluidity and mobility of words, ideas, thoughts, and knowledge. It can help them learn how to create several rough drafts, in quick succession, that sharpen an image, refine a concept, or lead to new ideas.

A spreadsheet program can help break a complex situation down into lists and arrays of smaller parts. It can display the whole forest and the individual trees in the forest, all at the same time. It can also reveal the relationships between all the parts.

A file-handling (data base) program can teach how to organize thoughts, feelings, experiences, and information. It can show how to group facts according to categories of likeness, how to sort and prioritize, and how to cross-reference facts that have certain traits in common.

Graphing languages, word processing languages, and telecommunications languages, singly or together, can teach how to better communicate feelings, ideas, and desires. They can teach how to use visual images and symbols, page layout and design, and grammar and style to communicate more effectively.

Magnets For Thinking, Learning, And Communication

Computers, like other media, can have a push-pull effect, depending on how people use them.

If computers are used inefficiently or inappropriately, they have to be pushed just to get meager, mediocre results.

On the other hand, computers can also exert a powerful pulling effect. They can be so attractive, so elegant that they will pull at the mind, like a magnet. They can almost seduce a person into performing a task or solving a problem.

Magnets And Road Maps

Computer tools can pull you like a magnet to the computer, but they can also become magnets inside your head that draw related information and ideas toward them. They can help you make sense out of chaos. They can let you mentally map out individual facts in some kind of logical, coherent, and practical order.

For example, what happens if you think about two things: a paper route and a spreadsheet? What kind of associations can you make? How might you map the paper route onto a spreadsheet?

You don't need to use a computer to do this exercise. Instead, you can perform what Albert Einstein called a thought experiment. You can build a mental prototype of a paper-route spreadsheet inside your head.

Associating spreadsheets and paper routes is not a dull, artificial, or mechanical activity. If you have the proper image, appreciation, and passion for using spreadsheets as a thinking skill, you start mapping the paper route onto the spreadsheet even before you know it. The spreadsheet, as a thinking tool, or metaphor, will draw your thoughts playfully and automatically. When you begin thinking about the paper route, your mind will unconsciously make an association with spreadsheets and figure out how the two are related.

For example, you might start thinking of the different houses on the paper route as columns. You might think of the people's names, addresses, telephone numbers, amounts owed, and your last collection date as rows in the spreadsheet.

You might also think of mapping the spreadsheeted paper route into a data base in which you could quickly determine who owes you for the papers, who is the most overdue, and what might be the most effective collection route for you to follow on your bicycle or in your car.

In fact, you might never put all this information onto the computer. It might be too much trouble entering the information and keeping it up-to-date. But this doesn't matter as long as you have a model of the spreadsheet or the data base inside your head.

For many, many applications in life, building a mental prototype inside your head is enough. It's not practical to go any further. The value of the computer skills is not that you use them on the computer, but that you can organize information, perform tasks, and solve problems better inside your head. This helps you become a better thinker, learner, and communicator on your own. You don't need a real computer around. You can carry one inside your head.

Learning Through Play

One of our greatest joys in life comes when we play—or when we feel we are playing. We might be working, but if it feels like play, we will be more motivated, more intense, and do a better job.

Passion and joy are not attributes of work but of love. And when we love what we are doing, it is never work. No matter how difficult the activity is, it feels like play.

I think that people can use computers to think playfully, learn playfully, and communicate playfully. The real joy of computing doesn't come from getting a job done faster, easier, or cheaper; it comes from making the job more challenging and more fun while you're doing it.

Are You A Neoprogrammer?

How is your relationship with your computer? Does your computer challenge you to think, learn, and communicate better? Does it make work more fun and interesting? Have you been able to take your computer skills with you when you leave the computer? Can you think on your own when your computer is turned off?

If you can, congratulations. Maybe you are a neoprogrammer and you don't even know it.

Whether you think you are a neoprogrammer or not, I'd like to hear your thoughts. What do you think about building a computer inside your head? Please write to me:

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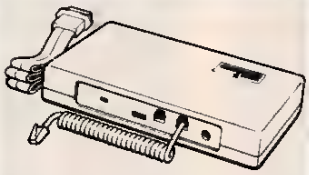

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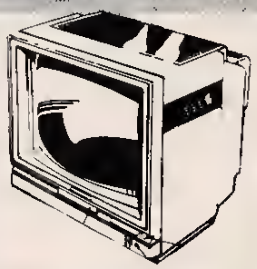

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REVIEWS

Exodus: Ultima III For Commodore 64

David K. Peacock

Exodus: Ultima III ushers in an exciting new era of fantasy role playing. The combination of superb graphics, music, and excellent playability makes *Exodus* a modern-day masterpiece. The game presents challenges requiring clear, creative thinking plus the patience and determination to thwart hundreds of monsters during a quest to defeat the ultimate foe: Exodus.

An Adventure In The Box

Just opening the box is an adventure. Inside, you discover such magical items as a book of wizard spells, another full of incantations, a comprehensive playbook along with a quick reference guide, and a colorful cloth map of the realm to be explored. Also included is a key in the form of a black disk which, once booted, opens the way to the universe of Sosaria, where your dreams and fears materialize and your wits are your only hope.

After making a copy of the master side of the disk, you are ready to begin your journey. First you must create several characters to do your bidding. Up to 20 characters may reside per disk, and up to 4 may travel together at one time. Each character has a name, sex, race, profession, and the four attributes of strength, dexterity, intelligence, and wisdom. Take your time and choose wisely among the five possible races and eleven professions. Also, consider which attributes are important for different characters while using up as few points as possible. Because there are so many options and tradeoffs involved, don't be surprised if some of your characters just don't cut it and you have to create new ones. The opportunity for multiple characters, with varying personalities and abilities, enhances the playing environment over the single character allowed in *Ultima II*.

Sosaria Awaits You

Once your party is formed, the quest begins. The disk spins for a moment, and you find yourself in the magical realm of Sosaria where the waves lap the shores and banners atop towns flap in the breeze. Walking along, you notice open grassy plains, tall mountains, and dark forests. Your ears are treated to enchanting medieval tunes throughout. Suddenly, a band of nasty orcs appear heading straight for you. You duck behind a range of hills where the monsters can't find you.

Now is the time to seek a town and outfit your party with much-needed supplies such as weapons and armor. Even though all your characters begin with cloth armor and a dagger apiece, better equipment could be a lifesaver. Remember, at the beginning, your characters are weak in every respect and must be nurtured until they have grown strong in body and mind and have gained knowledge along with experience. Until then, on to the safety of a town.

Weapon Trading

When you enter a town you'll

find many citizens roaming the streets. These people are worth getting to know, for only by speaking to everyone will you learn secrets to help guide you along. Also, clues can be found only with extensive exploration.

One major improvement of *Ultima III* upon its precursor concerns the weapons and armor shops. In *Ultima II*, you were limited to buying; now, in this game, you can buy and sell. The variety of weapons and armor is better than ever. In fact, there's a rumor that some weapons are effective over a great distance—that might be worth even a steep price.

As in *Ultima II*, there are places to buy food and several pubs whose bartenders hear tales and could give you a tip or two. There are also stables with sturdy horses. Occasionally your party will come across an oracle, a man of wisdom and divine insight who might impart some of his knowledge for part of your gold. Two new and useful places to visit are the thieves' guild shops and the houses of healing. You'll find this and more in towns, not to mention a couple of castles and enough dungeons to make your head spin.

Dungeons. The word conjures up images of dark, twisting passages, sounds of funeral organ music, and thoughts of impending doom. This is the mood of the endless dungeons of *Ultima III*. These 3-D dungeons represent a significant improvement over the simple underground mazes in *Ultima II*. Exploring your first dungeon is thrilling as you attempt to overcome pesky gremlins, howling winds, foul traps, dozens of monster groups, and enough twists and turns to make getting lost no problem at all.

Reaching the lower depths—where the goodies are—requires careful planning and a working knowledge of the layout of each level. Once the treasures are lo-

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cated, it will take cunning to get your party back out alive. If all the treasures had been packed into one or two dungeons, the game would have been almost perfect. Instead, vital things were spread out among many dungeons, decreasing the enjoyment of each one. After you've conquered one dungeon, the rest can become tedious. Of course, a true dungeon lover might see things differently.

A Four-Player Battlefield

A new combat routine has been implemented to accommodate up to four players. When a monster group is encountered, the scene shifts to a battlefield where all the monsters and all the players can be seen. Each player gets a turn in which he may reposition himself, attack an oncoming monster, or cast a spell. Then each of the monsters performs a similar act. The battle rages on, turn by turn, round by round—gone are the days of instant destruction.

Though the combat sequence is well conceived, it is simply too slow considering the number of monster groups which must be dealt with. Granted, the pace does quicken once the characters' attributes have been raised, but most of the game is spent slugging it out. Then, for the effort, your party garners a single chest containing barely enough gold to sustain everyone. On rare occasions, a small weapon or cheap armor may be locked inside. If more items were found more of the time, agonizing money problems would diminish and the party could proceed with more interesting tasks.

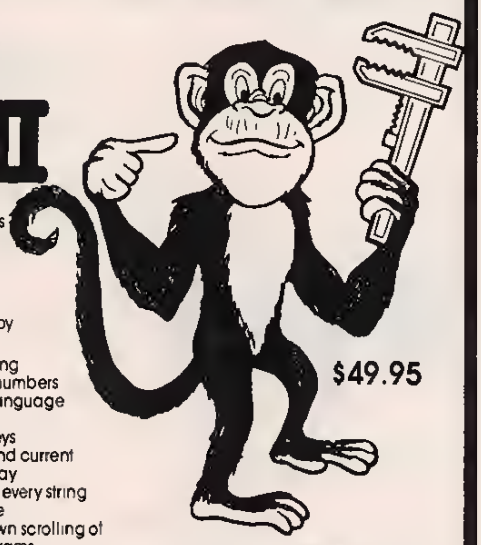
Wizards And Clerics

One of the best aspects of *Ultima III* involves the extensive use of magic. Now wizards and clerics can demonstrate their true value as they cleverly choose just the right spell to save the party from a slew of poisonous balrons. At first, your spell casters will be limited and somewhat ineffective, but as time passes and they grow smarter and wiser, they will become indispensable. The wizards' spells mainly center on harming evil creatures, while the clerical spells are good for healing and resurrection. Both sets include very handy spells for maneuvering in dungeons. The two books of magic provide wonderful insights into the workings of each spell, making the game even more bewitching. Overall, the use of magic in *Ultima III* is well integrated with the obstacles to be overcome.

Moon Gates

Time affects many aspects of the game. If, for example, a member of the party is poisoned, the passage of time slowly brings about his death. Otherwise, wounds heal with time and spell points increase to their

Monkey Wrench II



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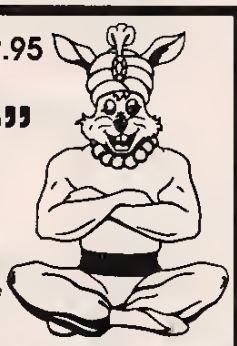

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maximum. Also, if your party has fought pirates and gained control of their ship, only time will allow the winds to shift in your favor so that you may explore new lands. Perhaps the most important effect of time concerns the ever-present moons, Trammel and Felucca. As they pass through their cycles, strange events take place. Warps in space, called moon gates, appear only at certain times. Somehow, the moons and gates are thought to be connected, hence the name. There is a rumor of a city hidden in a vast forest. Not only hidden, but also not always there. Time, moons, cities, gates—all interwoven to challenge the best adventurers. Such is the spell *Exodus* weaves about its players.

Game designer Lord British has outdone himself with his latest work of art. *Ultima II* was a fantastic game, but *Exodus: Ultima III* makes it seem like child's play in comparison. *Exodus* has achieved an unparalleled blend of setting, multi-character development, magic, plus a strongly integrated plot. The animated graphics sparkle with speed and color, and the sound effects achieve nothing less than a complete, evocative sound track. Except for a few places that tend to drag, *Exodus* is a delight to play, and I eagerly await the perils and pleasures of the fourth installment in the ultimate series.

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The Seven Cities Of Gold

James V. Trunzo

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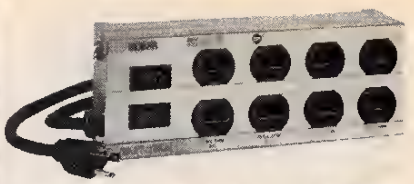
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known. Imagine, then, what it must have felt like to be with Pizarro, Cortez, Ponce de León, or Columbus and to sail away from the familiarity of Spain in search of discovery, gold, and fame.

The ocean was wide and uncharted, and the lands were filled with strangely painted natives who were often hostile. The storms were fierce and could easily blow the ship far off course. Starvation and a slow and painful death would follow if land was not sighted. Yet even in the face of such obstacles, the conquistadors were lured by the promise of gold and treasure. The ship's captain just had to be brave, smart, and lucky enough to discover a new world.

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One after one, the would-be explorers visited the court and on bended knees requested a grant to buy ships and hire men. In return they promised to establish missions for the church, forts to prove Spain's sovereignty, and gold to fill Spain's coffers.

Now you can experience the thrill of sighting land after a long, arduous sea voyage. You can also experience the pride in returning to Spain after having explored the Mayan Peninsula and discovered rich and fertile lands; or the shame of returning home after having lost most of your crew, several ships, and having no gold to show for your efforts.

Graphics And Strategy

Ozark Softscape, in conjunction with Electronic Arts, has produced a riveting new adventure game entitled *The Seven Cities of Gold* that places you at the helm of a fleet of ships and allows you to venture forth from Spain in search of a new world, wealth, and fame.

As in their award-winning game *M.U.L.E.*, the Bunten brothers have designed a graphically enhanced strategy game that challenges and educates as well as entertains. Upon booting *The Seven Cities of Gold*, the player finds himself in front of a palace in Spain. He has just been given a commission by the Spanish court; and as captain of a fleet of four newly outfitted ships, he is ready for his first voyage.

Leaving The Old World

After scrolling past a pub, his home, and an outfitters building (all important places when returning home from an expedition), the player leaves the Old World and ventures forth in search of the new. Sailing is controlled by the joystick, as are all actions and options. While at sea, the player may navigate the ship, view the map, and keep track of how many days have elapsed. The latter is especially important for several reasons. For one thing, your food supply isn't unlimited.

Eventually you will sight land. At this point, you will have to decide how much of the on-board supplies, goods, and men you want to take to explore the uncharted mass into which you have just bumped. Now the real fun begins. There will be lush jungles, fertile plains, intimidating mountain ranges, dangerous swamps, major rivers, and natives.

Jungles And Swamps

Accomplishing all your objectives is no easy task. Ambushes in the thick jungles will take their toll as will sickness in the swamps. Food is a constant source of worry; men won't travel on an empty stomach, let alone fight on one. And as the land grows cold with the approach of winter, food becomes scarcer.

Once you decide that it is time to return home (a decision often made easy by the loss of men, goods, etc.), you must navigate back to Spain. Assuming that you make it back, thwarting the best efforts of nature's storms, a trip to your home will provide you with a tally of what areas you have discovered, what forts and missions have been established, and how much wealth has been obtained. A trip to the court will give you a rating based upon your successes or failures. More gold, a promotion, or chastisement awaits you in the court. Finally, a trip to the pub allows you to record (save to disk) maps for future voyages. The outfitter? Most assuredly, it will be your first stop before weighing anchor for the next excursion. There you will buy food and goods, hire more men, and perhaps even purchase more ships.

Historical Accuracy

The mechanics of *The Seven Cities of Gold* are easily implemented and well-done. All movement, both on land or at sea, is handled by use of the joystick, as are all option selections and even combat. The graphics are well-done, and *Cities* contains over 2800 screens that represent the lands you will explore. The computer literally draws the map as you move about North, South, and Central America, all accurately depicted.

Your expedition is represented by an arrow moving over a variety of easily identified terrain. Symbols are used in various places to represent hundreds of different types of settlements, ranging from farmers and hunters to wealthy Aztec strongholds. It is upon entering one of these settlements that another of *Seven Cities'* delights is discovered.

Once the player has moved the arrow onto a settlement symbol, the screen symbol begins to magnify, increasing in size until it is replaced by a detailed graphic screen. The arrow is replaced by a conquistador who represents the expedition, and you find yourself in the middle of the settlement, rapidly

surrounded by natives. Find their chief and begin trading, or draw your sword.

An Enchanting Challenge

There are many more surprises in *The Seven Cities of Gold*. The program both challenges and enchants. It forces you to consider various strategies: What is the best way to outfit an expedition? Do you have enough men to establish forts? When should you return home for more supplies? Even the time of year can be an important factor.

And what happens after the player discovers the Mississippi or the Amazon, gold mines, the Fountain of Youth, and all the mysteries of the Americas? Is the game over? Not a chance. Aside from the fact that the game could be played again using different strategies and achieving higher rankings, *Seven Cities of Gold* provides a utility that randomly generates entire continents; no two are ever the same. Furthermore, all games can be played at one of three levels: novice, journeyman, or master.

Seven Cities of Gold
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Word Flyer

Steve Hudson, Assistant Editor, COMPUTE! Books

Dozens of educational programs have been released—some good, some less than good—but one of the most interesting is *Word Flyer*.

Best known for dynamic and challenging games like *Archon, Pinball Construction Set,* and *Worms?*, Electronic Arts has developed a reputation for sophisticated programs. *Word Flyer* is no exception. Like most educational programs, it uses graph-

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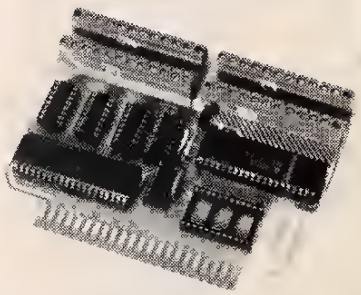

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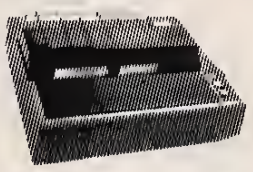

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ics and sound to reinforce learning, but uses them in a way that's both new and refreshing.

Word Flyer was developed by ChildWare, a programming group within Electronic Arts. Typically, ChildWare programs combine proven educational psychology with captivating programming, and *Word Flyer* is no exception.

The object of the game is straightforward: Use your joystick to maneuver word flyers and match zooming letters or words. It's a challenging and exciting game for young children. But there's learning amidst the laughter. Without realizing it, players are practicing valuable reading and vocabulary-building skills. On lower levels, the emphasis is on recognizing the letters of the alphabet; that makes the program valuable even for children who have not yet learned to read. Higher levels introduce words chosen from a built-in list of over 2000 entries. The approach is both original and nonviolent.

Booting The Birds

Two towers—built of the word *towers*—dominate the screen, one on the left and one on the right. Atop each tower sits a remarkably realistic-looking bird. A control panel runs across the bottom of the screen; it consists of flight level and speed indicators, a score bar, a timer, and a number-of-players indicator. On higher levels an alphabet bar appears too.

Play starts on flight 1, where emphasis is on the alphabet and on two-letter words. Flight 2 comes next, giving you the chance to match three-letter flyers. Subsequent flights introduce you to three- and four-letter flyers and faster speeds.

On flights 2 and above, you also gain access to the "alphabet bar." That allows you to select the first letter of your flyers. On levels 4 and 5 you can also change the color of your flyer to match the color of various zooming words.

If you're playing a two-player game, the hourglass timer will clock each player's turn. Need to take a break? At any time, on any level, you can move your flyer to the "rest nest" (an unmistakable mass of sticks and twigs) and press the joystick button to stop the timer. Also, at the beginning of each game (and at any point during play), you have the option of entering the "control panel" and changing any of the game parameters.

Although it takes a few minutes to get the hang of it, game play is fundamentally simple. Use your joystick to select a word from either word tower—the chosen word will be highlighted for you—and then press the button to send the chosen word flyer soaring into the air. Move it into position to match one of the soaring words, and press the joystick button again. If the match is correct, one of the birds will nod approval. If your match is incorrect, the bird will pronounce the avian equivalent of "uh-oh!"

Cooperative Scoring

In either case, your score will change appropriately. The score is increased when a player matches the flyer with the correct letter or word. On higher levels, additional points are awarded if the words' colors match too. Incorrect matches lower the score slightly and return you to the word tower. In two-player games, an incorrect match ends that player's turn.

Many parents will be pleased with this departure from the winner/loser approach of other multiplayer games. *Word Flyer* emphasizes constructive cooperation instead of conflict and destruction. The total score increases whenever either player correctly matches a letter or word. By working together, two players can move through the different levels more quickly than either could alone.

Parent and child can play together, working toward a common goal, and the child will learn to recognize letters, words, and colors. But he or she can learn the importance of cooperation too.

Where's The Word?

Word Flyer's graphics and sound are effective without being overpowering. Joystick control is responsive. The constantly changing list of letters or words holds interest, assuring many hours of satisfying and challenging play.

However, after several sessions, one odd quirk does become evident. In some cases, while exuberantly chasing down a zoomer, the flyer would fly off the top edge of the playing field. However, you can move the joystick to maneuver the flyer back onto the screen. Bothersome? A little, at first, and it might confuse very young children.

Also, at several points in the otherwise excellent manual, the reader is told that something will be described under a subsequent heading. It is mildly confusing (and occasionally annoying) to have to skip ahead to figure something out; in the case of instructions, at least, necessary redundancy is a feature that many software manuals still lack.

But once you figure it out—and it won't take long—control is simple and straightforward. Selecting flyers, colors, levels, and speeds quickly becomes second nature, allowing players to concentrate on the game itself. The educational goals underlying this game are pleasantly and effectively achieved. All in all, a deft piece of work.

Word Flyer
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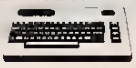

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Lightning Sort

Russ Gaspard

Last September COMPUTE! *published "Ultrasort," and we called it the fastest sorting program ever published for any home computer. It would sort a 1000-element array in less than eight seconds.*

It's been improved. Here's "Lightning Sort." It does the same thing in a breathtaking 2.1 seconds. Add this extraordinarily powerful subroutine to any of your BASIC programs where you need to alphabetize something. For the VIC, 64, and PC/PCjr. Atari users should refer to the accompanying sidebar and program "Bulldozer Sort."

The "Ultrasort" routine for Commodore computers (COMPUTE!, September 1983, p. 194) isn't as fast as it could be. After disassembling the code to study the algorithm, I found several opportunities to compact the code (mainly to reduce disk loading time) and to speed up the execution time. Using the "Sort Test" program from the original article as a benchmark, my "Lightning Sort" routine sorts a 1000-element array in an average of 2.1 seconds, versus 7.8 seconds for Ultrasort. That few seconds savings isn't much. But when I tried it on random 4000-element arrays the routine took an average of 10 seconds, versus 40 seconds for Ultrasort. A 400 percent speedup in execution time can be significant in applications where the sort routine is called repeatedly, or in sorting very large arrays.

The time for this type of algorithm to sort an N-element array is $T*N*Log_2N$ on the average, where T is about .21 milliseconds for the modified routine and .8 milliseconds for the original. Actual running time depends on the starting order of the array. Interestingly, whereas many sort algorithms run fastest when the original array is already in order, Hoare's Quicksort runs fastest on randomly ordered data. If you try it on an array which is already in correct order you'll find that it takes much longer (proportional to N^2).

Besides speeding up the execution, I was also able to reduce the amount of RAM needed from 908 bytes to 418 bytes. By storing the variables in RAM space above the actual sorting routine rather than within the routine, the actual program storage needed on disk is only 338 bytes. This means the saved program uses only two disk blocks, rather than the four required for the original.

Program 1 is a BASIC program which loads the machine language Lightning Sort routine for the Commodore 64. The routine is loaded into RAM from $C000 to $C152 (decimal 49152 to 49490), and writes variable data up to $C1A2 (decimal 49570). It is used in exactly the same way as Ultrasort. However, I prefer to define the call address 49152 as variable QS (either within the BASIC program or in direct mode) and then call the routine with:

```
SYS QS,N,AA$(K)
```

where K and N are the first element and the number of elements to sort, and AA$ is the array variable name, as in the Ultrasort article.

Program 2 is a BASIC loader for the VIC version of Lightning Sort. It automatically relocates the machine language to the top of available memory, regardless of the amount of expansion installed, and protects the sort routine from BASIC. The program also tells you the proper SYS to use to start the sorting.

Although Program 2 will run on an unexpanded VIC, we recommend that at least 8K expansion be used. With less than this, only a very few items can be sorted.

Program 3, the Sort Test program from the original Ultrasort article, can be used as a demonstration of Lightning Sort. The program creates an array, AA$, of 1000 random elements, then sorts them into order. If you are using a VIC with limited memory, you'll need to reduce the number of elements.

Program 1:
Lightning Sort Loader For The 64

Refer to the "Automatic Proofreader" article before typing this program in

```
10 I=49152:SUM=0                                :rem 136
20 READ A:IF A=256 THEN 40                      :rem 54
30 SUM=SUM+A:POKE I,A:I=I+1:GOTO 20
                                                :rem 79
40 IFSUM<>45295THENPRINT"ERROR IN DATA ST
   ATEMENTS":END                                :rem 191
50 PRINT"LIGHTNING SORT READY.":END
                                                :rem 214
49152 DATA 32,253,174,32,158,173   :rem 52
49158 DATA 32,247,183,165,20,133   :rem 52
49164 DATA 253,165,21,133,254,32   :rem 46
49170 DATA 253,174,32,158,173,162:rem 104
49176 DATA 1,165,71,157,85,193     :rem 221
49182 DATA 157,125,193,165,72,157:rem 114
```

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Atari Bubble And Bulldozer Sorting

Christine C. Genet

While machine language data sorting is extremely fast, there still may be times you will want to insert a simple BASIC sorting routine into a program. When the list to be sorted is small, bubble sorting is a good method to use. For larger lists, a technique called bulldozer sorting may be better.

Using The Bulldozer Sort Program

The program is a demonstration of the bulldozer sort. It asks how many numbers you want to sort and the value of the highest number in the list. It then generates random numbers in the desired range. When finished sorting, it prints all nonzero values to the screen.

To use the bulldozer sort as a subroutine, delete lines 70 through 85 and add a line to the beginning of the program defining the number of data elements (RN) and the maximum value of the data (MV). Also, change line 111 so that it will input the data in the way that is needed for your program. For example, to input data from the keyboard, change the line to read:

```
111 INPUT DT:IF DT>MV THEN 111
```

If you would like the sorted list printed to the screen as part of your subroutine, change line 550 to read:

```
550 RETURN
```

If you don't want a screen print, delete lines 500 through 550 and add the following line:

```
200 RETURN
```

How Bubble Sorting Works

The bubble sort is a commonly used method of sorting small lists of data into numerical or alphabetical order. While bubble sorts are easy to understand and use in programs, they are often too slow to use for large sorting tasks—bubble sorting requires many comparisons.

A bubble sort compares each item against the other unsorted items. If the item tested is larger than the one it is tested against, their positions are switched. This way, after all of the values have been tested once, the first position in the array contains the lowest number in the list.

Sorting A Stack Of Cards

Suppose we have a small stack of index cards that are out of order. We have four cards (numbered 1 through 4) to sort, and they are in the following order: 3, 2, 4, 1. To begin, we compare the first card (3) with the second (2). Since 2 is less than 3, we swap the cards and the order becomes: 2, 3, 4, 1.

Next we compare the first and third cards in the deck, and since 2 is less than 4, no swap occurs. Comparing the first and fourth cards, we see that they should be swapped (since 2 is greater than 1) and our stack of cards reads 1, 3, 4, 2.

Now we have placed the lowest card in the first position, so we can start our second series of comparisons with the second card in the deck. We compare the second and third cards (3 and 4) and make no swap, then compare the second and fourth cards, swapping 3 with 2. At this point, the first two positions in the deck are set and the order is 1, 2, 4, 3. Testing the third card is easy, since there is only one comparison left, and we switch the positions of 4 and 3 to finish our bubble sort with the array filled as follows: 1, 2, 3, 4.

Our mental sort took only six comparisons, and was pretty quick. But with longer lists, bubble sorting slows down greatly. The reason for this is that in any array with N elements, the number of comparisons required will be $N(N-1)/2$. This means that while a bubble sort of 20 items will require 190 comparisons, a list only four times as long (80 items) will require over 16 times as many comparisons (3160). In order to speed things up, we need to reduce the number of comparisons as much as possible.

A Faster Sort

An alternative is bulldozer sorting, first described by Isaac and Singleton, in *JACM* 3 (1956): 169–174. Bulldozer sorting uses *address calculation* to roughly position items in the array before sorting them. We bulldozer sort every time we use an index card file—we look for the correct section of files first, then sort the card into the specific place it belongs. On a computer, this sort works well for up to around 500 items and is faster than bubble sorting, although it uses more memory for the array.

Another feature of the bulldozer sort that makes it faster than the bubble sort is

that the bulldozer sort arranges the items one by one as the data is input—there is no long wait for the sort to finish after all of the data has been entered.

Address Calculation

To successfully predict where the data should be placed in the array before sorting, keep two requirements in mind:

1. The array used for sorting and storage of the data should be about 1.4 times as large as the data list, and
2. The formula for calculating the estimated address should be chosen to allow empty array spaces above, below, and between the sorted data elements.

The first requirement is easy to handle; just DIMension the data storage array to a value 1.4 times greater than the size of the data list.

Borrowing An Equation

To satisfy the second requirement—leaving extra space in the array—we need an equation that predicts a position for the lowest data element about 10 percent of the way into the array, and estimates the highest data element's position to be about 10 percent from the end of the array. Since the accuracy of the predicting equation is not critical, we'll use a simple one borrowed from geometry—the equation for a line—to put the data in the correct general area of the array. Then we'll sort the data into the exact location.

For example, if we had 200 job numbers (or other data elements) ranging in value from 0 to 500, we would DIMension the array to 280. We would also want the lowest value to be placed by the equation in the 28th array position and the highest value to be sent to the 252nd position.

The general equation for a line is $y=mx+b$, where m is the slope and b is the place where the line crosses the y-axis. The slope of a line is the rise (change in the value of y) divided by the run (change in the value of x). We want predicted points to be in the middle 80 percent of the array, so we multiply m in the above equation by 0.8. For the value of b, simply use 10 percent of the array size (28). The estimated array position for x=250 would be:

$$y=mx+b=0.8(280/500)x+28=0.448(250)+28=140$$

Note that of the 281 array positions created by DIMensioning, position 140 is very near the center. Using the same equation to predict a position for x=251, though, yields a value of 140.448, which rounds to 140.

Obviously one array element can hold only one data value, and this is where sorting becomes necessary. When an array location is already being used, the bulldozer sort compares the two values and rearranges the list. It is this readjusting feature of the bulldozer sort that requires the 40 percent extra array storage. The program slows down as it sorts near the end of the data list because more of the predicted locations are filled and more sorting is necessary.

Bulldozer Sort

```
EL 70 PRINT "{CLEAR}HOW MANY RANDOM
      DATA ELEMENTS";
JM 75 INPUT RN
PF 80 ? "WHAT MAXIMUM VALUE";
YA 85 INPUT MV
EL 90 AS=INT(.5+RN*1.4):DIM JN(AS):
      DN=0:I=0
BP 95 PRINT "CLEARING THE ARRAY ";
OI 100 FOR A=0 TO AS:JN(A)=0:NEXT A
NG 105 PRINT "ARRAY CLEARED"
LH 110 I=I+1
GA 111 DT=(INT(100*MV*RND(0)+.5)/10
      0)
FD 115 PRINT "DATA ELEMENT: ";I;"
      {4 SPACES}VALUE: ";DT
FH 130 APP=INT((.8*AS*DT/MV)+.1*AS
      +.5)
EJ 135 C=0
FH 138 REM ****** Lines 140-160 dete
      rmine which subroutine to acc
      ess to sort data correctly **
      ****
OF 140 IF JN(APP)=0 THEN JN(APP)=DT:
      GOTO 180
IC 150 IF JN(APP)>=DT THEN GOSUB 500
      0:GOTO 180
EF 160 IF JN(APP)<DT THEN GOSUB 6000
      :GOTO 180
AO 180 IF I<RN THEN 110
CB 500 REM **** PRINTING SORTED NUMB
      ERS ****
BD 505 PRINT "NUMBERS SORTED. NOW PR
      INTING."
JM 508 DN=0
GD 510 FOR B=0 TO AS
EJ 515 REM *** Array positions witho
      ut numbers are not printed ou
      t ***
GF 519 REM **** Zeros are not printe
      d ****
IG 520 IF JN(B)=0 THEN 540
DO 530 DN=DN+1:? "ARRAY ELEMENT: ";D
      N;"{4 SPACES}VALUE: ";JN(B)
BK 540 NEXT B
HB 550 END
GE 5000 REM **** Placing numbers les
        s than job presently at loca
        tion****
CD 5010 APP=APP-1
OG 5020 C=C+1
```

```
HG 5030 IF JN(APP)=0 THEN JN(APP)=DT
        :RETURN
IF 5040 IF JN(APP)>=DT THEN C=C-1
CH 5050 APP=APP-1
OK 5060 C=C+1
II 5070 IF JN(APP)=0 THEN 5110
MG 5080 IF JN(APP)>=DT THEN C=C-1:GO
        TO 5050
NB 5090 GOTO 5050
CK 5100 IF C<=1 THEN JN(APP)=DT:RETU
        RN
LP 5105 REM **** Shifting other numb
        ers to make room for new num
        ber ****
HJ 5110 D=1
AD 5120 IF D=C THEN JN(APP)=DT:RETUR
        N
PG 5130 JN(APP)=JN(APP+1)
OL 5140 D=D+1
CG 5150 APP=APP+1
MN 5160 GOTO 5120
IA 6000 REM **** Placing numbers gre
        ater than # presently at loc
        ation****
CC 6010 APP=APP+1
OH 6020 C=C+1
HH 6030 IF JN(APP)=0 THEN JN(APP)=DT
        :RETURN
EH 6040 IF JN(APP)<DT THEN C=C-1
CG 6050 APP=APP+1
OL 6060 C=C+1
IK 6070 IF JN(APP)=0 THEN 6110
IJ 6080 IF JN(APP)<DT THEN C=C-1:GOT
        O 6050
ND 6090 GOTO 6050
CL 6100 IF C<=1 THEN JN(APP)=DT:RETU
        RN
LC 6105 REM **** Shifting other numb
        ers to make room for new num
        ber ****
HF 6110 D=1
AE 6120 IF D=C THEN JN(APP)=DT:RETUR
        N
PJ 6130 JN(APP)=JN(APP-1)
OM 6140 D=D+1
CJ 6150 APP=APP-1
MP 6160 GOTO 6120
```

```
49188 DATA 105,193,157,145,193,165
                                  :rem 167
49194 DATA 253,208,2,198,254,198  :rem 70
49200 DATA 253,160,3,24,189,125   :rem 249
49206 DATA 193,101,253,157,125,193
                                  :rem 150
49212 DATA 189,145,193,101,254,157
                                  :rem 155
49218 DATA 145,193,136,208,236,189
                                  :rem 166
49224 DATA 85,193,133,80,189,105  :rem 60
49230 DATA 193,133,81,189,125,193:rem 108
49236 DATA 133,82,189,145,193,133:rem 111
49242 DATA 83,32,21,193,144,4     :rem 152
49248 DATA 202,208,228,96,165,82  :rem 64
49254 DATA 133,78,165,83,133,79   :rem 18
49260 DATA 160,2,177,78,153,250    :rem 2
49266 DATA 0,136,16,248,48,11     :rem 158
49272 DATA 24,165,80,105,3,133    :rem 200
49278 DATA 80,144,2,230,81,160    :rem 204
49284 DATA 2,177,80,153,247,0     :rem 160
49290 DATA 136,16,248,32,32,193    :rem 4
49296 DATA 144,230,56,165,82,233  :rem 59
49302 DATA 3,133,82,176,2,198     :rem 158
49308 DATA 83,32,21,193,176,31    :rem 208
49314 DATA 160,2,177,82,153,247    :rem 3
49320 DATA 0,136,16,248,32,32     :rem 145
49326 DATA 193,176,225,160,2,177  :rem 58
49332 DATA 80,145,82,185,247,0    :rem 210
49338 DATA 145,80,136,16,244,48   :rem 10
49344 DATA 183,160,2,177,80,145    :rem 4
49350 DATA 78,185,250,0,145,80    :rem 209
49356 DATA 136,16,244,24,189,85   :rem 17
49362 DATA 193,125,125,193,133,82:rem 105
49368 DATA 189,105,193,125,145,193
                                  :rem 168
49374 DATA 133,83,102,83,102,82   :rem 254
49380 DATA 32,21,193,176,22,189    :rem 7
49386 DATA 85,193,157,86,193,189  :rem 88
49392 DATA 105,193,157,106,193,32:rem 106
49398 DATA 53,193,232,32,69,193   :rem 20
49404 DATA 76,71,192,189,125,193  :rem 67
49410 DATA 157,126,193,189,145,193
                                  :rem 164
49416 DATA 157,146,193,32,69,193  :rem 68
49422 DATA 232,32,53,193,76,71    :rem 209
49428 DATA 192,165,81,197,83,208  :rem 72
49434 DATA 4,165,80,197,82,96     :rem 176
49440 DATA 160,255,200,196,247,176
                                  :rem 155
49446 DATA 11,196,250,176,6,177    :rem 13
49452 DATA 248,209,251,240,241,96:rem 107
49458 DATA 196,250,96,24,165,80    :rem 20
49464 DATA 105,3,157,85,193,165    :rem 13
49470 DATA 81,105,0,157,105,193   :rem 253
49476 DATA 96,56,165,80,233,3     :rem 173
49482 DATA 157,125,193,165,81,233:rem 112
49488 DATA 0,157,145,193,96,256    :rem 23
```

Program 2:
Lightning Sort Loader For VIC

Refer to the "Automatic Proofreader" article before typing this program in.

```
5 HI=PEEK(56)-2:S=HI*256:S1=S     :rem 179
10 POKE 56,HI:POKE 55,0           :rem 231
20 READ A:IF A=256 THEN PRINT"TO RUN SORT
   , USE:{5 SPACES}SYS"S1:END     :rem 106
25 IF A<0 THEN POKE S,ABS(A+2)+HI:S=S+1:G
   OTO 20                          :rem 79
30 POKE S,A:S=S+1:GOTO 20         :rem 160
4608 DATA 32,253,206,32,158,205   :rem 249
4614 DATA 32,247,215,165,20,133   :rem 244
4620 DATA 253,165,21,133,254,32   :rem 242
4626 DATA 253,206,32,158,205,162   :rem 45
4632 DATA 1,165,71,157,85,-3      :rem 100
4638 DATA 157,125,-3,165,72,157    :rem 2
4644 DATA 105,-3,157,145,-3,165   :rem 241
4650 DATA 253,208,2,198,254,198    :rem 10
4656 DATA 253,160,3,24,189,125    :rem 207
4662 DATA -3,101,253,157,125,-3   :rem 233
4668 DATA 189,145,-3,101,254,157   :rem 52
4674 DATA 145,-3,136,208,236,189   :rem 54
4680 DATA 85,-3,133,80,189,105    :rem 204
4686 DATA -3,133,81,189,125,-3    :rem 200
4692 DATA 133,82,189,145,-3,133   :rem 255
4698 DATA 83,32,21,-3,144,4        :rem 49
4704 DATA 202,208,228,96,165,82     :rem 4
4710 DATA 133,78,165,83,133,79    :rem 214
4716 DATA 160,2,177,78,153,250    :rem 207
4722 DATA 0,136,16,248,48,11       :rem 98
4728 DATA 24,165,80,105,3,133     :rem 149
```

```
4734 DATA 80,144,2,230,81,160     :rem 144
4740 DATA 2,177,80,153,247,0      :rem 100
4746 DATA 136,16,248,32,32,-3     :rem 148
4752 DATA 144,230,56,165,82,233   :rem 255
4758 DATA 3,133,82,176,2,198      :rem 116
4764 DATA 83,32,21,-3,176,31       :rem 96
4770 DATA 160,2,177,82,153,247    :rem 208
4776 DATA 0,136,16,248,32,32      :rem 103
4782 DATA -3,176,225,160,2,177    :rem 202
4788 DATA 80,145,82,185,247,0     :rem 168
4794 DATA 145,80,136,16,244,48    :rem 215
4800 DATA 183,160,2,177,80,145    :rem 200
4806 DATA 78,185,250,0,145,80     :rem 158
4812 DATA 136,16,244,24,189,85    :rem 213
4818 DATA -3,125,125,-3,133,82    :rem 188
4824 DATA 189,105,-3,125,145,-3   :rem 242
4830 DATA 133,83,102,83,102,82    :rem 194
4836 DATA 32,21,-3,176,22,189     :rem 151
4842 DATA 85,-3,157,86,-3,189     :rem 162
4848 DATA 105,-3,157,106,-3,32    :rem 189
4854 DATA 53,-3,232,32,69,-3       :rem 94
4860 DATA 76,71,-2,189,125,-3     :rem 150
4866 DATA 157,126,-3,189,145,-3     :rem 0
4872 DATA 157,146,-3,32,69,-3     :rem 151
4878 DATA 232,32,53,-3,76,71      :rem 106
4884 DATA -2,165,81,197,83,208    :rem 216
4890 DATA 4,165,80,197,82,96      :rem 125
4896 DATA 160,255,200,196,247,176:rem 113
4902 DATA 11,196,250,176,6,177    :rem 209
4908 DATA 248,209,251,240,241,96   :rem 56
4914 DATA 196,250,96,24,165,80    :rem 216
4920 DATA 105,3,157,85,-3,165     :rem 148
4926 DATA 81,105,0,157,105,-3     :rem 141
4932 DATA 96,56,165,80,233,3      :rem 113
4938 DATA 157,125,-3,165,81,233     :rem 0
4944 DATA 0,157,145,-3,96,256     :rem 158
```

Program 3: Sort Test

```
100 PRINT"{CLR}"                          :rem 245
110 N=1000                                :rem 222
120 DIM AA$(N)                            :rem 178
130 PRINT"CREATING"N" RANDOM STRINGS"
                                          :rem 47
140 SD=-TI:A=RND(SD)                      :rem 183
150 FOR I=1 TO N                           :rem 37
160 PRINTI"{UP}"                           :rem 66
170 N1=INT(RND(1)*10+1)                   :rem 221
180 A$=""                                 :rem 127
190 FOR J=1 TO N1                          :rem 91
200 B$=CHR$(INT(RND(1)*26+65))             :rem 81
210 A$=A$+B$                               :rem 43
220 NEXT J                                 :rem 29
230 AA$(I)=A$                             :rem 119
240 NEXT I                                 :rem 30
250 PRINT"HIT ANY KEY TO START SORT"
                                          :rem 151
260 GET A$:IF A$="" THEN 260               :rem 83
270 PRINT"SORTING..."                      :rem 26
280 T1=TI                                 :rem 249
291 REM SYS 49152,N,AA$(1) FOR 64:rem 163
292 REM USE SYS VALUE GENERATED BY THE LO
    ADER FOR VIC                          :rem 117
300 SYS 49152,N,AA$(I)                    :rem 125
310 T2=TI                                 :rem 244
320 PRINT"DONE"                           :rem 140
330 PRINT"HIT ANY KEY TO PRINT SORTED STR
    INGS"                                  :rem 72
340 GET A$:IF A$="" THEN 340               :rem 81
350 FORI=1 TO N:PRINT I,AA$(I):NEXT
                                          :rem 28
```

Programmer's Notes: PC And PCjr Version

Tim Victor, Editorial Programmer

The PC and PCjr version of "Lightning Sort" (Program 4) is based on the same algorithm as the version for Commodore computers, but runs in about one-third the time, due to the greater speed and power of the 8088 microprocessor used in the IBM computers. There are a couple of differences in the way that this program is loaded and used.

The BASIC loader program calculates a checksum from the DATA statements to help identify typing errors, then creates a disk file named "LSORT.BAS", containing the ML routine in binary form. The demonstration (Program 5) loads this file into memory using BLOAD and sets LSORT to the address of the sort routine. This variable is needed because IBM BASIC's CALL statement will only accept a variable name for the address of an ML routine.

Lightning Sort uses the first parameter in the CALL statement to find the array that it will sort. This is actually the address of the first string in the array, AA$(1) in the demonstration program, not the address of the array itself. The second parameter, N%, tells Lightning Sort how many strings are in the array. Variable names also have to be used for parameters, which is the reason for using N% instead of just plain 1000, and this version expects the length parameter to be an integer variable (a variable whose name ends with a percent sign).

Lightning Sort is loaded at address hex FF00 in BASIC's default segment. During a sort, the 256 bytes starting at hex FE00 are also used. To protect this memory, both programs start with the instruction CLEAR,&HFE00, which sets the top of BASIC's workspace to hex FE00.

```
360 PRINT:PRINT N" ELEMENTS SORTED IN"(T2
    -T1)/60"SECONDS"                  :rem 181
```

Program 4: Lightning Sort Loader For PC/PCjr

```
100 CLEAR,&HFE00
110 ON ERROR GOTO 10000
120 DEF SEG
130 CHECKSUM = 0
140 ADDRESS = &HFF00
150 READ MLDATA
160 WHILE MLDATA <> -1
170 POKE ADDRESS,MLDATA
```

```
180 CHECKSUM = CHECKSUM + MLDATA
190 ADDRESS = ADDRESS + 1
200 READ MLDATA
210 WEND
220 IF CHECKSUM <> 22937 THEN ERROR 200
230 BSAVE "lsort",&HFF00,&HDC
240 END
1000 DATA 85,137,229,139,118,6,139,4
1010 DATA 72,185,3,0,247,225,139,86
1020 DATA 8,1,208,189,252,254,137,86
1030 DATA 2,137,70,0,252,41,192,80
1040 DATA 139,94,0,139,86,2,57,211
1050 DATA 127,3,233,129,0,135,211,232
1060 DATA 139,0,118,5,131,195,3,235
1070 DATA 246,135,211,57,211,126,31,131
1080 DATA 235,3,232,120,0,114,244,138
1090 DATA 15,139,71,1,135,211,134,15
1100 DATA 135,71,1,135,211,136,15,137
1110 DATA 71,1,135,211,235,214,139,118
1120 DATA 0,138,4,134,7,136,4,139
1130 DATA 68,1,135,71,1,137,68,1
1140 DATA 139,86,0,3,86,2,209,234
1150 DATA 57,218,114,23,139,70,2,131
1160 DATA 195,3,137,94,2,131,237,4
1170 DATA 131,235,6,137,94,0,137,70
1180 DATA 2,235,21,139,70,0,131,235
1190 DATA 3,137,94,0,131,237,4,131
1200 DATA 195,6,137,94,2,137,70,0
1210 DATA 88,64,80,233,114,255,88,72
1220 DATA 124,7,80,131,197,4,233,103
1230 DATA 255,93,202,4,0,139,118,0
1240 DATA 181,0,138,12,139,116,1,58
1250 DATA 15,118,2,138,15,139,127,1
1260 DATA 243,166,116,1,195,139,126,0
1270 DATA 138,13,58,15,195,-1
10000 IF ERR <> 200 THEN ON ERROR GOTO 0
10010 PRINT "Error in ML data: check for
 typo's"
10020 RESUME 240
```

Program 5: PC/PCjr Sorting Demonstration

```
10 CLEAR,&HFE00 : DEF SEG : CLS
20 BLOAD "lsort",&HFF00:LSORT=&HFF00
30 N%=1000
40 DIM AA$(N%)
50 LOCATE 2,16 : PRINT "Creating ";N%;"r
andom strings"
60 DEF SEG=&H40:RANDOMIZE PEEK(&H6C)
70 FOR I=1 TO N%:LOCATE 3,16:PRINT I
80 J%=RND(1)*10+1
90 A$="":FOR K=1 TO J%
100 A$=A$+CHR$(INT(RND(1)*26+65))
110 NEXT K
120 AA$(I)=A$
130 NEXT I
140 CLS:LOCATE 2,16:PRINT "Any key to st
art sort:"
150 A$="":WHILE A$="":A$=INKEY$:WEND
160 LOCATE 3,16:PRINT "sorting-  ";
170 SS=PEEK(&H6C)+256*PEEK(&H6D)
180 DEF SEG:CALL LSORT(AA$(1),N%)
190 DEF SEG=&H40:FS=PEEK(&H6C)+256*PEEK(
&H6D)
200 PRINT "done"
210 LOCATE 5,16:PRINT "Any key to print
sorted strings"
215 A$="":WHILE A$="":A$=INKEY$:WEND
220 FOR I=1 TO N%:PRINT AA$(I):NEXT
230 PRINT N%;"elements sorted in";(FS-SS
)/18;"seconds"
```

Notes For Apple Version Of Lightning Sort

Tim Victor, Editorial Programmer

The Apple version of "Lightning Sort," shown in Programs 6 and 7, requires an Apple II with at least 48K of random access memory and one disk drive. It has been tested on an Apple II Plus under DOS 3.3 and on an Apple IIc under ProDOS as well as DOS 3.3. The Applesoft demonstration program in Program 7 uses the BLOAD command to load the file LIGHTNING.SORT. This is a binary file containing the Lightning Sort program that is entered from Program 6 using the Apple II's built-in ML monitor.

Boot your computer, then type "CALL-151" to use the monitor. When you hit RETURN, the Applesoft input prompt will be replaced by an asterisk ("*"), the monitor's prompt. To enter a line from the listing, replace the hyphen after the first four-digit hexadecimal number with a colon. The first line in the listing would be entered as

```
9400: 20 B1 00 20 05 E1 A5 A0
```

Since no checksums are used in the listing, it's a good idea to make sure that the program in memory is correct. You can ask the monitor to display the contents of any memory location by typing its address as a hexadecimal number and hitting return. To examine a range of memory locations, type the address of the first location in the range, a period ("."), and then the address of the last location in the range. For example, Program 6 was made simply by entering "9400.9551" in response to the asterisk prompt.

When you're sure that the program is entered correctly, save it to disk using the BSAVE command. All DOS commands work in exactly the same way when entered from the monitor as when they are used in Applesoft. You can CATALOG, BLOAD, BSAVE, DELETE, and even LOAD and SAVE BASIC programs. To save the program you just entered, type "BSAVE LIGHTNING.SORT,A$9400,L$152" and hit RETURN. DOS will create a binary file named "LIGHTNING.SORT" and store in it $152 (338 in decimal notation) bytes beginning at memory location $9400 (decimal 37888).

Program 6: Lightning Sort For The Apple

```
9400- 20 B1 00 20 05 E1 A5 A0
9408- 85 FE A5 A1 85 FD 20 B1
```

```
9410- 00 20 E3 DF A2 01 A5 83
9418- 9D 52 95 9D 7A 95 A5 84
9420- 9D 66 95 9D 8E 95 A5 FD
9428- D0 02 C6 FE C6 FD A0 03
9430- 18 8D 7A 95 65 FD 9D 7A
9438- 95 8D 8E 95 65 FE 9D 8E
9440- 95 88 D0 EC 8D 52 95 85
9448- 1C 8D 66 95 85 1D 8D 7A
9450- 95 85 1E 8D 8E 95 85 1F
9458- 20 12 95 90 04 CA D0 E4
9460- 60 A5 1E 85 1A A5 1F 85
9468- 18 A0 02 81 1A 99 FA 00
9470- 88 10 F8 30 08 18 A5 1C
9478- 69 03 85 1C 90 02 E6 1D
9480- A0 02 B1 1C 99 ED 00 88
9488- 10 F8 20 1D 95 90 E6 38
9490- A5 1E E9 03 85 1E B0 02
9498- C6 1F 20 12 95 B0 1F A0
94A0- 02 81 1E 99 ED 00 88 10
94A8- F8 20 1D 95 B0 E1 A0 02
94B0- 81 1C 91 1E 89 ED 00 91
94B8- 1C 88 10 F4 30 87 A0 02
94C0- 81 1C 91 1A 89 FA 00 91
94C8- 1C 88 10 F4 18 8D 52 95
94D0- 7D 7A 95 85 1E 8D 66 95
94D8- 7D 8E 95 85 1F 66 1F 66
94E0- 1E 20 12 95 B0 16 8D 52
94E8- 95 9D 53 95 8D 66 95 9D
94F0- 67 95 20 32 95 E8 20 42
94F8- 95 4C 44 94 8D 7A 95 9D
9500- 78 95 8D 8E 95 9D 8F 95
9508- 20 42 95 E8 20 32 95 4C
9510- 44 94 A5 1D C5 1F D0 04
9518- A5 1C C5 1E 60 A0 FF C8
9520- C4 ED B0 08 C4 FA B0 06
9528- 81 EE D1 F8 F0 F1 60 C4
9530- FA 60 18 A5 1C 69 03 9D
9538- 52 95 A5 1D 69 00 9D 66
9540- 95 60 38 A5 1C E9 03 9D
9548- 7A 95 A5 1D E9 00 9D 8E
9550- 95 60
```

Program 7: Lightning Sort Loader For The Apple

```
10  HIMEM: 38400: HOME : HTAB 8: PRINT
     "APPLE LIGHTNING SORT DEMO"
20  HTAB 10: PRINT "LOADING LIGHTNING.SORT"
30  PRINT  CHR$ (4)"BLOAD LIGHTNING. SORT"
40  HIMEM: 37887
50 N = 1000
60  DIM AA$(N)
70  HOME : PRINT "CREATING "N" RANDO
     M STRINGS"
80  FOR I = 1 TO N
90  VTAB 2: PRINT I
100 N1 =  INT ( RND (1) * 10 + 1)
110 A$ = ""
120  FOR J = 1 TO N1
130 B$ =  CHR$ ( INT ( RND (1) * 26 + 65))
140 A$ = A$ + B$
150  NEXT J
160 AA$(I) = A$
170  NEXT I
180  PRINT "HIT ANY KEY TO START SORT"
190  GET A$: IF A$ = "" THEN 190
200  PRINT "SORTING..." CHR$ (7)
210  CALL 37888,N,AA$(1)
220  PRINT "DONE" CHR$ (7)
230  PRINT "HIT ANY KEY TO PRINT SOR
     TED STRINGS"
240  GET A$: IF A$ = "" THEN 240
250  FOR I = 1 TO N: PRINT I,AA$(I): NEXT
```


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Glenn M. Kleiman

Aids For The Blind

Computers provide new and powerful aids for blind people. With special input and output devices and programs, computers enable blind people to more effectively substitute hearing and touch for sight and to use books, magazines, and newspapers that would otherwise be inaccessible to them. Computers can help blind people enjoy new opportunities for education, employment, social interaction, and recreation.

Much of this information about aids for the blind has been provided by the staff of the Sensory Aids Foundation of Palo Alto, California. They train blind people in job skills and help them find suitable jobs. They receive support from some of the major computer and electronics companies in Silicon Valley, and have placed workers at these companies. Other information has been provided by Telesensory Systems, Inc., the developers of Optacon and VersaBraille.

Computer Speech Synthesis

Speech synthesizers and text-to-speech conversion programs make it possible for computers to pronounce any word. The speech is not perfect, but people understand it easily after they get accustomed to it. During a visit to the Sensory Aids Foundation, I watched a demonstration of a talking terminal—a computer terminal combined with a speech synthesizer.

The blind user of the talking terminal has a control that lets him move a pointer to any line on the display screen. He can have the computer announce what line the pointer is on and speak the words on that line. He can have it repeat any words or read letter by letter. He can use the keyboard to edit the line.

Talking terminals make almost all the capabilities of a computer accessible to blind people. At Sensory Aids, blind people learn to use talking terminals for data entry, information retrieval, word processing, and programming.

Many educational programs could be used by blind people if the computer spoke what appears on the display screen. Staff members at Sensory Aids are revising some popular programs so that blind people can use them. During my visit, I saw a version of *MasterType* that was adapted for the blind. In the *MasterType* program, letters and words "attack" a central station. The user defends the station by typing the letters and words before they reach the station. In the adapted version of this program, the computer says the letters and words to be typed, and announces whether they have been typed correctly and quickly enough to defend the station.

Large Print Displays

Many people with impaired vision cannot read normal print, but can read large, high-contrast print. There are several ways to create large letters on the computer screen with standard equipment. One is to simply use a television or video monitor with a large display screen. Another is to use the computer's graphics capability to create large letters. In addition, many computer printers can produce large type on paper. With a suitable printer, any information stored in the computer can be printed in large letters.

A special large-print display processor, manufactured by Visualtek, magnifies letters on personal computer screens up to 16 times their

Dr. Glenn M. Kleiman is an educational psychologist and software developer. He is the author of Brave New Schools: How Computers Can Change Education *(Reston/Prentice-Hall) and the designer of* Square Pairs, *an educational game program (Scholastic, Inc.).*

usual size. A control panel lets the user set the scanning rate at which the letters move across the display screen.

Tactile Forms

Many people cannot see any letters, no matter how large. But these people can read when the letters are converted to a tactile form. One device which does that, Optacon, is already used by many blind people.

Optacon consists of a small camera, an electronics unit, and a stimulator array. The array is composed of 144 miniature rods. The electronics unit interprets the light pattern received by the camera and sends signals that cause certain rods to vibrate, thereby producing a tactile analogue to the light pattern. Some training is necessary to learn to read the vibrating patterns, but once this is mastered the blind person has access to all printed materials. Special adapters are available so that Optacon can be used to read computer screens and calculator displays.

Other devices use Braille, a system of writing in which each letter is represented by a pattern of raised dots in a 2 × 3 grid. Blind people read by feeling the dot patterns.

Although widely used, Braille has several disadvantages. Braille books are extremely bulky: A standard student dictionary fills a three-foot-square box. Braille typewriters are noisy and slow. Errors in Braille type cannot be corrected, since the raised dots cannot be erased. Braille books are therefore expensive, and most books, newspapers, and magazines are never made available in Braille.

Braille Word Processing

Special Braille printers can be interfaced to computers so that any information in the computer can be transformed to Braille. This provides a remedy for the problem of Braille not being correctable. A word processing program can be used to produce a Braille text after all corrections have been made on the computer screen.

Other Braille output devices can be interfaced to computers. One example is a device that contains sets of pins arranged in the 2 × 3 Braille grid. Each pin can be raised or lowered, thereby providing a mechanical Braille display. This device can be controlled by computer programs to produce instant Braille for a blind computer user.

A special device called VersaBraille incorporates recent advances in computer technology. VersaBraille is composed of a mechanical Braille display, a cassette information storage component, and a specially designed Braille keyboard, all under the control of a built-in computer. Information can be entered from the keyboard, revised and corrected (editing capabilities are built-in), stored on cassette, and transformed to Braille whenever needed.

VersaBraille provides a solution to the bulkiness of Braille. It is a self-contained unit that is easy to carry and can store 400 pages of Braille on a standard cassette tape.

A major advantage of VersaBraille is that it can be linked to a computer via a standard serial interface. A blind person can connect VersaBraille to a computer and quickly transfer information from the computer to VersaBraille's cassette storage system. The VersaBraille can then be taken away from the computer and read where and when convenient. A VersaBraille user can also take notes during class lectures, write reports, or enter any other information. He or she can then connect VersaBraille to a computer, transfer the information to the computer's memory, and use the computer to print the information, store it, or send it to others via an electronic mail system.

Computerized Letter Recognition

Speech synthesizers and text-to-speech programs can convert any words stored in a computer to speech. Other devices can convert information stored in a computer to large letter displays or to Braille or other tactile signals. However, much of the information people need is in books, not computers. To fully use the capability of computers to convert text to speech, Braille, or large print, we need efficient ways of transferring text from books to computers.

Special cameras and pattern recognition programs have been used for some time to recognize specially designed letters and numbers, such as the account numbers on checks. The camera converts the pattern of each letter into a binary code. A computer is programmed to process the binary code and determine which letter it represents.

In the last few years, devices and programs have been developed which make it possible for computers to recognize most typewritten characters and to adjust automatically for different type styles and sizes. In the next few years, this technology is likely to be perfected and become more widely available. (Only very limited success can be expected with handwritten letters, due to the large variations found in even one person's handwriting.)

Letter-recognition devices can be combined with appropriate output devices to produce large size displays, speech or Braille. Letter-recognition devices can also be combined with Braille printers to expedite the production of Braille books.

Converting Print To Speech

One impressive example of technology which serves the visually handicapped is the Kurzweil

Reading Machine that converts print to speech. This machine combines sophisticated pattern recognition, speech synthesis, and text-to-speech conversion capabilities. It lets blind users control how the material is read. They can set the speed of reading and adjust the tonality of the voice. They can stop the reading at any time, have the last few words or lines repeated, request the machine to spell out words or announce punctuation and capitalization, and mark certain words or phrases for later reference. This reading machine is currently a very expensive device. But as the technology advances and prices decrease, machines with these capabilities should become available to all blind people.

Technology For The Blind

Of 51 blind people who were assisted by the Sensory Aids Foundation during a one-year period, fifteen are now programmers, computer operators, or systems analysts. Other occupations include design engineer, word processor, medical transcriber, account clerk, attorney, cashier, clerk-typist, physicist, and college professor. Their employers include Apple, Hewlett-Packard, Pacific Telephone, Stanford Linear Accelerator, Department of Immigration, Internal Revenue Service, and other businesses, educational institutions, and government agencies.

Current technological aids include Optacon, VersaBraille, talking terminals, talking calculators, and closed circuit television systems that produce enlarged images of print on a television screen. These devices, and others now in development, can dramatically increase the opportunities available to blind people.

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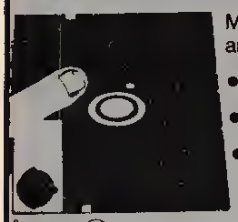

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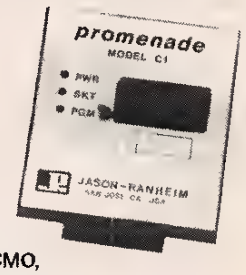

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INSIGHT: Atari

Bill Wilkinson

Last month we discussed how to make programs designed for the Atari 400 and 800 load and run automatically on the new XL series without having to hold the option key down. We also looked at a way to make patches into Atari DOS 2.0s to enable it to work with the new enhanced density 1050 disk drive. The procedure is easy, but requires two disk drives. Just type in the source code (the portion printed last month and the continuation found in this issue) using an assembler capable of placing its object code directly in memory. Assemble it after LISTing or SAVEing the source code to disk. After assembling it once, change line number 1000 to read:

```
1000 .OPT NOLIST,OBJ
```

and assemble the code once more.

DOS should now be patched. Hit the SYSTEM RESET key and give the DOS command from your assembler. You should now be in the DOS menu (if you're not, something has gone wrong). Format a new disk using option I and then write the DOS files using option H. This will insure that everything is right and will give you a safe copy of your newly patched DOS.

The Tricky Part

There's one more step necessary to finish the procedure. Turn off your computer, put your BASIC (or BASIC XL) cartridge into your machine, and turn the power back on, thus booting the disk that was just formatted. Place a blank diskette into the 1050 drive that you are using as drive 2 and, from BASIC, type the following command:

```
XIO 254,#1,0,34,"D2:"
```

Drive 2 should now contain an enhanced-density diskette. Now hit the SYSTEM RESET key so that DOS will recognize the new density. Finally, go into DOS and write the DOS files to the new diskette (D2), using option H from the menu.

If everything has been done properly, drive 2 should now have an enhanced-density diskette containing the patched DOS. Once you have this master completed, creating others is simple and can be done with the I and H options in the DOS menu.

Patches To Atari DOS 2.0s

```
                    1350 ;
                    1360 ; BEGIN THE ACTUAL PATCHES
                    1370 ;
                    1380 ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                    1390 ;
                    1400 ; This patch allows either $21 or $22 as
                    1410 ;   a format command.
                    1420 ;
0000                1430     *=  $07B5
07B5                1440 PATCHFORMAT
07B5 A920           1450     LDA #$20    ; format cmds are $21 or $22
07B7 2D0203         1460     AND DCBCMD  ; is this a format cmd?
07BA D002           1470     BNE $07BE   ; bit $20 is set, so yes...read
                    1480 ;
                    1490 ; This patch modifies the drive type
                    1500 ;   reported by DINIT for use in DRVTBL
                    1510 ;
07BC                1520     *=  $0819
0819                1530 PATCHINIT
0819 ADEA02         1540     LDA $02EA   ; get drive status
081C 0A             1550     ASL A       ; and this sequence...
081D 08             1560     PHP         ; ...will serve to
081E 0A             1570     ASL A       ; ...convert the status
081F 2A             1580     ROL A       ; ...$00, $20, and $80
0820 2A             1590     ROL A       ; ...to the more usable
0821 2A             1600     ROL A       ; ...$00, $01, and $80
0822 28             1610     PLP         ; (more usable because what we
0823 6A             1620     ROR A       ; want are $01,$02, and $81)
```

```
                   1630 ;
                   1640 ;
                   1650 ; This patch allows SETUP to call the main
                   1660 ;   patch-it-all-up routine
                   1670 ;
Ø824               1680    *=  $1184
                   1690 ; patch to SETUP code
                   1700 ;
1184 BE1113        1710    LDX DRVTBL,Y
1187 2ØØ115        1720    JSR PATCHSETUP ; the real work
118A A8            1730    TAY
118B FØ4E          1740    BEQ DERR1
                   1750 ;
                   1760 ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                   1770 ;
                   1780 ; The major patch:
                   1790 ;   Here we determine the type of drive for
                   18ØØ ;   the current operation and patch various
                   1810 ;   locations (including LDA # instructions)
                   1820 ;
118D               1830    *=  $15Ø1
15Ø1               1840 PATCHSETUP
15Ø1 8E7213        1850    STX TRUETYPE ; save true drive type
15Ø4 E8            1860    INX         ; convert Ø or 1 to 1 or 2
15Ø5 8A            1870    TXA
15Ø6 29Ø3          1880    AND #$Ø3    ; mask off 1Ø5Ø bit
15Ø8 8DFE12        1890    STA DRVTYP  ; ...and save it
15ØB 48            19ØØ    PHA         ; and keep it for later return
                   1910    ;           now we set up the tricky stuff
                   1920 ;
                   1930 ; we need different VTOC bases and sizes
                   1940 ;   and different disk sizes
                   1950 ;
15ØC AØØA          1960    LDY #$ØA    ; 81Ø: start of vtoc
15ØE A964          1970    LDA #9Ø+$ØA ; 81Ø: end of vtoc bytes
151Ø A221          1980    LDX #DCBCFD ; 81Ø: format command
1512 2C7213        1990    BIT TRUETYPE ; test drive type
1515 1ØØ5          2ØØØ    BPL SGLDBLJOIN ; 81Ø, all ok
1517 AØØ6          2Ø1Ø    LDY #$Ø6    ; 1Ø5Ø: start of vtoc
1519 A98Ø          2Ø2Ø    LDA #122+$Ø6 ; 1Ø5Ø: end of vtoc bytes
151B E8            2Ø3Ø    INX         ; 1Ø5Ø: format command is '"'
                   2Ø4Ø ;
                   2Ø5Ø ; now store these values into code (shudder!)
                   2Ø6Ø ;
151C               2Ø7Ø SGLDBLJOIN
                   2Ø8Ø ;
151C 8E23ØD        2Ø9Ø    STX $ØD23   ; where format command is loaded
                   21ØØ ;
                   211Ø ; the various uses of START-OF-VTOC
                   212Ø ;
                   213Ø ;
151F 8C8ØØD        214Ø    STY $ØD8Ø   ; in deallocation of boot
1522 8CEE1Ø        215Ø    STY $1ØEE   ; in FRESECT
1525 8C4211        216Ø    STY $1142   ; in GETSECTOR, displacement
1528 88            217Ø    DEY
1529 8CØ711        218Ø    STY $11Ø7   ; at start of GETSECTOR
                   219Ø ;
                   22ØØ ; and the uses of END-OF-VTOC
                   221Ø ;
152C 8DØA11        222Ø    STA $11ØA   ; check end in GETSECTOR
152F 8D7AØD        223Ø    STA $ØD7A   ; a CPY in format code
1532 98            224Ø    TYA
```

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```
1533 18                 CLC
1534 692E               ADC #46       ; adjust for ...
1536 8D840D             STA $0D84     ; the directory dealloc in fmt
1539 AE0113             LDX CURFCB    ; recover original value
153C 68                 PLA
153D 60                 RTS
                   ;
                   ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                   ;
                   ;
                   ; This is another major patch...
                   ;    instead of using set values for VTOC
                   ;    info, we pick from one of two tables
                   ;
                   ;
153E                    *=  $0D37
0D37               PATCHXFORMAT
0D37 1027               BPL XF0       ; same source, but XF0 has moved
                   ;
                   ;
0D39                    *=  $0D52
0D52               TBL810
0D52 02                 .BYTE 2
0D53 C302               .WORD 707,707
0D55 C302
0D57 00FF               .BYTE 0,$FF
0D59               TBL1050
0D59 02                 .BYTE 2
0D5A C503               .WORD 965,965
0D5C C503
0D5E 00FF               .BYTE 0,$FF
                   ;
                   ;
                   ; we have moved the label xf0
                   ; ...to make room for the tables
                   ;
0D60               XF0
0D60 A000               LDY #0
0D62 B9520D        XF01 LDA TBL810,Y
0D65 2C7213             BIT TRUETYPE
0D68 1003               BPL TYPEOK
0D6A B9590D             LDA TBL1050,Y
0D6D               TYPEOK
0D6D 9145               STA (ZDRVA),Y
0D6F C8                 INY
0D70 C007               CPY #7
0D72 D0EE               BNE XF01
                   ;
0D74               XF02
0D74 9145               STA (ZDRVA),Y
0D76 C8                 INY
0D77 10FB               BPL XF02
0D79 EA                 NOP
0D7A EA                 NOP
0D7B EA                 NOP
0D7C EA                 NOP
                   ;
                   ; This patch allows the user to choose
                   ;    diskette type for formatting via
                   ;    the 'XIO 254' command
                   ;
0D7D                    *=  XFV       ; Where the format vector is
```

```
ØBD6 4C7313      2850      JMP XFVPATCH
                 2860 ;
                 2870 ; The label 'Z' designates some unused
                 2880 ;   memory in the original DOS 2.Øs
                 2890 ;
ØBD9             2900      *=  Z
1372 ØØ          2910 TRUETYPE .BYTE Ø ; Where PATCHSETUP saves true disk type
                 2920 ;
                 2930 ; This code becomes the beginning of
                 2940 ;   the FORMAT code
                 2950 ;
1373             2960 XFVPATCH
1373 BD4BØ3      2970      LDA ICAUX2,X ; Get AUX2 value
1376 FØØ3        2980      BEQ XFVP2    ; zero...don't do anything
1378 8D23ØD      2990      STA $ØD23    ; non-zero...assume it is type of format
137B             3000 XFVP2
137B 4C18ØD      3010      JMP XFORMAT
                 3020 ;
                 3030 ;
                 3040 ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                 3050 ;
                 3060 ; end of patches for 1050 drive
                 3070 ;
                 3080 ;
                 3090 ; BEGIN patches for BURST I/O
                 3100 ;
                 3110 ; from COMPUTE!, July, 1982
                 3120 ;
                 3130 ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                 3140 ;
137E             3150      *=  $ØA1F
                 3160 ;
                 3170 ; first, patch the code where WTBUR used to be
                 3180 ;
ØA1F             3190 WTBUR
ØA1F             3200 BURSTIO
ØA1F BD8213      3210      LDA FCBOTC,X ; open type code
ØA22 49ØC        3220      EOR #$ØC     ; check for mode 12 (update)
ØA24 FØ24        3230      BEQ NOBURST
ØA26 6A          3240      ROR A        ; move carry to MSB of A-reg
ØA27 EA          3250      NOP          ; filler only
ØA28             3260 TBURST
                 3270 ;
                 3280 ; ... and STA BURTYP remains...but
                 3290 ;     BURTYP is negative if BURSTIO was
                 3300 ;     called from GET-BYTE and positive
                 3310 ;     if it was called from PUT-BYTE
                 3320 ;
ØA28             3330      *=  $ØA41
                 3340 ; so we must patch here to count for the sense
                 3350 ;   of BURTYP being inverted from original
                 3360 ;
ØA41 1ØØ9        3370      BPL WRBUR
                 3380 ;
ØA43             3390      *=  $ØAD4
                 3400 ;
                 3410 ; finally, we must patch the GET-BYTE call
                 3420 ;   so that it JSR's to new location
                 3430 ;
ØAD4 201FØA      3440      JSR BURSTIO
                 3450 ;
ØAD7             3460      .END
```

©

Commodore Autoboot

David W Martin

This utility makes loading and running programs quick and easy, and can also be used as a form of copy protection. For the VIC-20 and Commodore 64 with a disk drive.

Have you ever wondered how some commercial programs run automatically after they're loaded? "Autoboot" enables you to add this convenient feature to your own programs.

Type in and SAVE Autoboot. VIC users should substitute the following for lines 481 and 491 before saving:

```
481 DATA 165,175,133,46,165,174,133,45,32
    ,89,198,32                          :rem 234
491 DATA 142,198,76,174,199             :rem 77
```

To use Autoboot, first load the BASIC program that you want to make bootable. Then enter POKE 43,0:POKE 44,1 and SAVE the program using a different filename. This version of the program will be used by Autoboot. Now load and run Autoboot and enter the name of the modified version when prompted. Autoboot will then turn it into an autoboot program by directly changing certain disk sectors. The sector numbers are displayed on the screen as Autoboot runs.

Since the VIC and 64 automatically relocate programs when loading, all autobooted programs must be loaded using a nonrelocatable load as follows:

LOAD *"filename"*,8,1

Of course, any BASIC program can be made to load and run from disk just by typing:

LOAD *"filename"*,8:

and pressing SHIFT–RUN/STOP instead of RETURN. But the power of Autoboot lies in the copy protection it provides. To copy protect your autorun programs, add POKE 808,100 (VIC), or POKE 808,234 (64) as the first line in your program before saving the modified version to be used by Autoboot. This will disable the RUN/STOP key, the RESTORE key, and the LIST command as soon as the program runs. Since the autobooted program will run as soon as it's loaded, the user won't be able to break out of the program to SAVE it.

Autoboot

Refer to the "Automatic Proofreader" article before typing this program in.

```
100 PRINT"{CLR} AUTOBOOT ":T=18:S=1:D$="0
    ":OPEN15,8,15,"I"+D$            :rem 248
110 OPEN2,8,2,"#"+"0"               :rem 234
120 REM **** LOCATE TARGET          :rem 15B
130 INPUT"FILENAME";NA$:LN=LEN(NA$)
                                    :rem 139
140 GOSUB210:GOSUB300               :rem 245
150 IFT=0THENPRINTNA$" NOT FOUND":GOTO540
                                     :rem 18
160 GOTO140                         :rem 101
170 GOTO540                         :rem 106
180 REM ***POINT TO BYTE AND GET IT INTO
    {SPACE}X.                       :rem 10B
190 PRINT#15,"B-P:"2,L:GET#2,A$:IFA$=""TH
    ENA$=CHR$(0)                    :rem 197
200 X=ASC(A$):RETURN                :rem 206
210 PRINT"TRACK"T" SECTOR"S         :rem 148
220 PRINT#15,"U1:"2;D$;T;S          :rem 204
230 L=0:GOSUB180:T=X:L=1:GOSUB1B0:S=X:RET
    URN                              :rem 71
240 REM *** CHECK FOR FULL MATCH    :rem 221
250 FORJ=ITOI+LN:L=J:GOSUB180:IFX=0ORX=16
    0THEN270                        :rem 130
260 X$=X$+CHR$(X):NEXTJ             :rem 101
270 IFX$<>NA$THENX$="":RETURN        :rem 23
280 L=I-2:GOSUB1B0:TT=X:L=I-1:GOSUB1B0:SS
    =X:PRINT                        :rem 142
290 GOTO340                         :rem 107
300 REM *** CHECK THROUGH ONE BLOCK FOR N
    AME MATCH                        :rem 54
310 FORI=5TO230STEP32                :rem 15
320 L=I:GOSUB1B0:IFCHR$(X)=LEFT$(NA$,1)TH
    ENGOSUB240                      :rem 95
```

```
330 NEXTI:RETURN                        :rem 56
340 REM *** ACCESS 1ST SECTOR OF TARGET P
    ROGRAM                              :rem 199
350 T=TT:S=SS:GOSUB210                  :rem 142
360 L=2:GOSUB180:AL=X:L=3:GOSUB180:AH=X:S
    A=AL+AH*256                         :rem 183
370 IFSA<>256THENPRINT:PRINTNA$" IS NOT P
    REPARED FOR AUTOBOOT":GOTO540:rem 142
380 REM *** ESTABLISH FALSE STACK:rem 125
400 PRINT#15,"U1:"2;DR;TT;SS:PRINT
                                        :rem 104
410 FORPB=173TO254STEP2:PRINT#15,"B-P:"2;
    PB                                  :rem 74
420 PRINT#2,CHR$(96);                   :rem 160
430 PRINT#15,"B-P:"2;PB+1               :rem 113
440 PRINT#2,CHR$(3);:PRINT"*";:NEXT:PRINT
                                        :rem 22
450 PRINT#15,"U2:"2;DR;TT;SS            :rem 167
460 GOSUB210:PRINT                      :rem 116
470 REM ***PUT AUTOBOOT CODE ONTO PAGE 3
                                        :rem 14
481 DATA165,175,133,46,165,174,133,45,32,
    89,166,32                           :rem 229
491 DATA 142,166,76,174,167             :rem 67
500 PRINT#15,"U1:"2;DR;T;S              :rem 251
510 FORPB=105TO121:READBY:PRINT#15,"B-P:"
    2;PB                                :rem 194
520 PRINT#2,CHR$(BY);:PRINT". ";:NEXT:PRI
    NT:PRINTNA$" CAN NOW BOOT ITSELF"
                                        :rem 0
530 PRINT#15,"U2:"2;DR;T;S              :rem 255
540 CLOSE2:CLOSE15                     :rem 87 ©
```


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Atari Paddle Fixer

William Griner

Here's a quick fix for the Atari paddle jitters that still preserves the paddles' range.

The Atari paddles are so sensitive that the heat of a hand or any jarring can change their value. Some paddle-based games don't take the sensitivity into account, causing their characters to flicker annoyingly. Try this:

```
KN 1000 REM get the paddle value
IG 1010 PV=PADDLE(PN): IF ABS(PV-DPV
        )>1 THEN OPV=PV: RETURN
LF 1020 PV=OPV: RETURN
```

where:

PN is the paddle number (0–7)

PV is the value read from the paddle

OPV is the old paddle value (initialized to whatever value you wish)

Centered Values

The above subroutine keeps the paddle centered between the adjacent values. It takes a difference of two steps or more to change the paddle value. This is not to say that the paddle will use only all even or all odd values. For example, if the paddle is at value 77, it will not be allowed to move directly to 76 or 78. If you want to move from 77 to 78, you will have to move to 80 or 75, then to 78.

Better Than Brackets

This method is better than dividing the paddle range by a number since doing so creates fixed brackets of possible values and does nothing to keep the paddle value from straddling the bracket boundaries. This method could also be used to keep the paddle in a wide bracket, allowing only for coarse movement, yet giving access to the entire range of the paddle's values. ©

Apple Editing Hints

Patrick Moyer

Most computer owners develop a love-hate relationship with at least one feature of their machines. For Apple owners, this feature is often the editing functions. Here is a review of Apple editing controls and protocols and some tips on making the process easier and more effective.

The Apple uses a combination of screen editing and line editing. Changes are made by moving the cursor to a particular line which has been listed on the screen and retyping that line. This retyping is usually accomplished with the right arrow key. As the right arrow is pressed, the cursor moves to the right, reentering all it passes over. A change is made by typing over what is already there, or by inserting the correction through a combination of cursor moves.

Physical, Logical

Therefore, to make a change, we must specify the line to be changed. In this case, we are talking about a line of BASIC, not a line displayed on the screen. The BASIC line is called a *logical line*, as opposed to the *physical line* that is displayed on the screen. A logical line may contain multiple BASIC commands and may be up to 255 characters long. The physical display line is the 40-letter width of the screen.

Before a BASIC line can be changed, it must be listed. It is best to clear the screen with the HOME command initially. This eliminates confusion about what was changed and what wasn't.

When a line is listed, the computer puts one space between words or variables, two spaces after the line number, seven spaces at the end of the first physical line, and five spaces on the right and left sides of the remaining physical lines.

Most of the time, these extra spaces and lines are of little consequence. One can just merrily right-arrow over them with no harm. The one exception occurs in string information (characters in quotes). This causes a problem. If a string is broken between two or more physical lines during the listing process, and you right-arrow to retype, 12 additional spaces will be inserted between the last character on the first line and the first character on the next line. Certainly not what's wanted. The common solution is to avoid the right arrow and use the cursor with the <ESC>K sequence instead.

Simplified Cursor Control

There's an even simpler solution. Let's edit a line step by step to demonstrate this technique (<ESC> is the ESC KEY, <RET> is the RETURN KEY):

Here's the line as originally typed:

```
10PRINT"THIS IS A LONG LINE OF STRING
DATA"<RET>
```

List the line. It looks like this:

```
LIST10<RET>
10 PRINT "THIS IS A LONG LINE OF STR
   ING DATA"
```

We then type <ESC>I, repeating the I key until the cursor is over the second digit of the line number; J is pressed to move the cursor one space to the left. (This J keypress is important. If you forget it and continue the editing process, you will gain a line in your program. Line 0 will be created, but more about that later.)

Once you've moved left, leave <ESC> mode. This is done by pressing any key not having meaning in <ESC> mode. Because some keys not normally used for cursor movement do have special meaning, it's best to press the space bar. Remember, this will not move the cursor.

We can now use the right arrow to "retype" the line to the place of the change. The repeat key can be used to speed this process. Let's say you've used the right arrow until it appears after the last quote. The line on the screen looks no different. However, if we LIST the line, we now see this:

```
10 PRINT "THIS IS A LONG LINE OF STR
   ING DATA"
```

If we type RUN we get:

```
RUN<RET>
THIS IS A LONG LINE OF STR    ING DAT
A
```

Eliminating Problem Margins

The common solution, again, is to right-arrow to the R in STR, then type <ESC> and press K repeatedly to move the cursor until you reach the I in ING. Anyone who has done this often will know how easy it is to forget <ESC> K, and end up with a string of K's.

The solution is simply to eliminate those extra margins unless you need them. Let's start

with the same original line:

```
10PRINT"THIS IS A LONG LINE OF STRING
DATA"<RET>
```

To edit the line we type:

```
HOME:POKE33,30:LIST10<RET>
```

The HOME gives us a clean screen to work with; the LIST puts the line to be edited on the screen. A POKE instruction places a single number into an "address" in the computer's memory. Address 33 controls the width of the screen display. Placing the number 30 in it reduces the size of the screen to 30 characters wide rather than 40.

Caution: The POKE must be done before the LIST for this method to work. The HOME is optional, but prevents a very confusing screen. (Try it. You'll see what I mean.) The screen will erase and display:

```
10  PRINT"THIS IS A LONG LINE OF S
TRING DATA"
```

As you can see, the line is 30 characters wide without the extra margin spaces. Move the cursor to the line number as usual. The right arrow may be used without ill effect. It will go directly from the S on the first display line to the T on the second line without inserting any blanks. This eliminates the need to use the <ESC> K sequence.

Once you have finished editing, you will need to type TEXT. This command will return you to normal 40-character screen mode.

Duplicating Lines

One strength of Apple II editing is the ability to duplicate lines. Let's try an example:

```
HOME: POKE33,30:LIST10<RET>
10  PRINT"THIS IS A LINE TO BE
DUPLICATED"
```

Next move the cursor up to the line using the normal <ESC>I. When the cursor arrives over the number, move it left until it is over the first digit of the number. Then press the space bar as before; but prior to using the right arrow, retype the line number, say, 20. Then use the right arrow to "retype" the line as described above until you reach the end of the logical line. At this point, press RETURN. If you LIST the program, you'll see:

```
HOME:POKE33,30:LIST<ret>
10  PRINT"THIS IS A LINE TO BE
DUPLICATED"
20  PRINT"THIS IS A LINE TO BE
DUPLICATED"
```

Once you have moved your cursor up to the number and changed it, you do not have to reuse the entire line. You can treat it like any line to be edited further if necessary.

Easy Program Merge

This technique can also be used on a limited scale to merge two programs. Let's say you have a favorite subroutine of three or four lines which you wish to add to a program. You could use the merge function of the Renumber program on the Systems Master, or the program that is part of the Programmer's Toolkit. If you don't have these programs or you don't have them handy, here is a simple procedure:

1. Save the program you are working on.
2. Load the program which contains the lines to be copied to your new program.
3. Clear the screen, change width, and list lines (using HOME:POKE33,30:LIST statements).
4. Now, load the program the lines are to be added to.
5. Using the normal <ESC> and right-arrow commands, edit each line without changes. It's best to edit the last line first and work up the screen, entering each line one at a time. This is because when multiple lines are listed and edited, once <RET> is pressed, the line number below it is partially destroyed and has to be retyped by hand. There's nothing wrong with changing the line numbers to fit your new program if the current line numbers are a problem.
6. Once all lines are edited, save the program. If you list it, you'll find the lines are now part of your program.

Finally, if you want to cancel a particular change as long as you have not pressed <RET> yet, cancel the editing of the line by typing <CTL> X. Be sure that you press the <CTL> key first, then X. The machine will answer with a backward slash. If you list the line, it will be unchanged. ©

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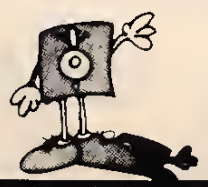

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Jim Butterfield, Associate Editor

Math And Tables

I'm frequently asked for addresses within ROM that do certain operations, usually mathematical functions. I do my best to talk programmers out of this approach if possible.

For one thing, the addresses of the ROM routines vary from machine to machine. I'd prefer to see a programmer borrow the code from the ROMs and include it in the program. At least that way, transportability is not a problem.

Using ROM math routines is often awkward. They often call for one or more values to be placed into floating point accumulators before calling, and return values in the same areas. A floating point number is often an inconvenient format and takes a fair-sized conversion routine to bring back to the more convenient "fixed point" notation used by most machine language programmers. The total effort can turn out to be greater than programming it yourself.

But the main reason that I try to discourage use of these routines is this: They are designed for a certain number of digits of accuracy, and your program usually wants either greater or less accuracy. If you need less, you're wasting processor time working out the extra places. If you need more, the built-in routine will not do the job for you.

A Question

I was recently asked by a user to supply the address of the logarithm routine within a certain computer. It would have been easy to just answer the question, but I balked. I asked the user to define his objective.

This makes an interesting case history, since the objectives were changed partway through the exercise. We have a chance to see a couple of approaches to avoiding the built-in routines.

My first thought was to replace the ROM log routine with a streamlined machine language version. There are several efficient ways of calculating a logarithm; any book on numerical analysis (or an encyclopedia) will supply information on this.

First Approach

After questioning the user closely, the objective appeared to be this: An eight-bit reading was being taken from a remote device. He desired to convert this reading to a base ten logarithm (with appropriate scaling) for display purposes, and the accuracy of the result was to be 16 bits.

My concept of the approach changed. The magic words, "eight bits," had been spoken. The objectives were still a bit fuzzy, since it's hard to get a full 16 bits of useful data when your original data was only 8 bits accurate; but not to worry on that score for the moment.

Here's the pitch: If you have an eight-bit value to work through any mathematical function, use a table. There are only 256 possible values to be worked out, 256 questions and 256 corresponding answers.

We'll need to have two tables—one for the low part of the answer and one for the high part—but that's no problem: 512 bytes of storage is usually not hard to come by.

Looking up things in a table of 256 values is the ultimate in simplicity. It's sometimes called a "list type lookup," and the principle is very simple. Put the original value into an index register, and read out the indexed answer. Our code might read something like the following:

```
LDX  —input register—
LDA  LOWTABLE,X
STA  LOWRESULT
LDA  HIGHTABLE,X
STA  HIGHRESULT
```

No loops, no math, no complexity: Five instructions and it's done. We must be sure to prepare the table in advance, but that's a one-shot task. In fact, BASIC could do the job for us and POKE the values into the table.

Second Approach

When the requirement was examined more closely, the rules changed and the problem was inverted: Given a 16-bit reading, compute the base ten logarithm to 8 bits of accuracy. The eight bits, by the way, were to be used to draw a high-resolution graph; 256 points were quite sufficient for the resolution required.

This requirement makes a little more sense: Converting 16 bits into 8 involves a loss of accuracy, but that was compatible with the display objective.

We still have the magic words "eight bits" embedded in the problem, but this time they describe the result. We can still use our table approach if we invert the way we use the table.

Let's build our table this way: For each of the 256 entries, we'll put the corresponding "anti logarithm" in the table. When we search the table to find the closest match to our original value, the answer will turn out to be the number of the table entry.

An example might illustrate what I mean here. Suppose the 16-bit input number has a value of 2000. The desired result, allowing for the scale, will be 165. In slot 165 of the tables (high and low), I'll find a value that's quite close to 2000. My task: search the table to find the closest value.

Binary Splitting

This isn't hard to do. Most of us have learned to search a table by using a "binary split" method, splitting the table in half again and again until we find the value we want. And on a table of size 256, a computer can do a very efficient job of binary splitting. Eight comparisons and it's all over.

The code would follow these lines:

```
LDA  #$80
STA  MASK
```

This says, "we're going to split the table into chunks of 128 (hex 80) this time around."

```
LDX  #$00
STX  POINTER
```

We'll kick off starting at position zero in the table. Here comes the loop:

```
LOOP  LDA  POINTER
      ORA  MASK
      TAX
```

We've added our offset of 128 to the starting position of zero, so our first comparison will be at the midpoint of the 256 table.

```
COMPARE .....
```

Let's fudge the COMPARE coding for the moment. We'll need to load our high and low bytes into A, compare to the table high and low (indexed, of course) and decide whether our value is higher or lower than the table entry. If our value is LOW, we'll branch ahead to LOW; otherwise, we continue with HIGH:

```
HIGH    STX  POINTER
```

If our value is high, we store the index. If not, we skip this instruction and continue with the old value in POINTER.

```
LOW     LSR  MASK
```

Our mask contained 128, the size of the "split." Now we are dividing it by two so that it becomes 64, and 32 the next time, followed by 16, and so on. Eventually, we'll end up with zero as the bit rolls out of the end of the byte.

```
        BNE  LOOP
```

We go back to do another comparison. Let's see what has happened. POINTER started at zero. If our input value is lower than table item 128, POINTER will stay at zero and the next comparison will be with item 64. On the other hand, if our input value is higher than table entry 128, POINTER will be changed to 128, and the next comparison will be with item 192. In other words, we'll split the upper half or the lower half depending on how the previous comparison went.

It's not hard to see how the program zeros in on the answer after eight comparisons. Finally, MASK becomes zero, the program stops looping, and the answer may be found in POINTER.

The user started out looking for a logarithm routine in ROM, and ended up with something much better: faster, more compact, and well-suited to the application.

And there was a free bonus. After looking at this approach, the user discovered that he could do something he had previously thought impractical: switch to a new display scale—linear, split scale, or whatever—with no difficulty. It was just a matter of turning the tables. ©

Commodore Disk Pattern Matching
Part 1

Jim Butterfield, Associate Editor

*The flexible Commodore DOS allows the user to LOAD, Scratch, and obtain a directory of files using the symbols * and ? as pattern matchers. The quirks of these two symbols can, however, cause problems. For one thing, you might accidentally erase an entire diskette.*

Commodore disk drives are versatile; sometimes we don't realize how versatile they are. In this article, we'll discuss *pattern matching*: how it works, and how to use it to get rid of an annoying "comma" file that sometimes appears on your disk directory.

First, a recommendation: Unless you have 4.0 BASIC (in the PET/CBM series of computers), learn how to use the *Wedge* or *DOS Wedge* utility program. It's a great convenience. We'll refer to wedge commands within this article. The DOS Wedge has many handy features, but the two most important are these: You can find out about a disk error at any time by typing the @ key followed by a RETURN; and you can examine a disk directory without disturbing the program within your computer's memory by typing @$ followed by RETURN.

Pattern Matching

It's possible to identify one or more programs on disk without specifying their full names. Match the missing part of the filename by using a pattern. The two characters used for this are:

? – to match any single character;
* – to match any following characters.

If I have two files, one named DIG and the other, DOG, I can specify a name which matches both files with D?G—the question mark matches any character. If I have files named HOUSE, HO, HOTDOG, and HORRIBLE, I can match them all with HO*—the asterisk matches any group of characters, including no character.

This is good if you can't remember a filename exactly. If you have a file that might be called CATFOOD or might be called CAT FOOD, but you can't remember which, you can load it regardless of name with LOAD "CAT*",8. The first file whose name begins with CAT will be loaded. Unfortunately, you might discover that instead of the program you wanted, you have loaded something else, such as CATCH-MICE. The first name in the directory that matches will be the one loaded.

We can use pattern matching to get around this problem. If you load the directory using pattern matching, you'll see all programs that fit the pattern. To examine CAT programs, type:

```
LOAD "$0:CAT*",8
```

or, with the wedge program:

```
@$0:CAT*
```

You'll see a list of all programs (if any) whose names begin with the characters CAT, which allows you to select the one you want.

Command Variations

Note that LOAD picks the first program that matches, but the directory picks all programs that match.

It's probably obvious that SAVE must not al-

low pattern matching. You must save a real name, not an approximation. Thus, SAVE "CAT*",8 will produce a syntax error from the disk.

The Scratch command does accept pattern matching; all files that match will be removed from the disk. Use pattern matching with great care when using Scratch; you could remove more files than you planned.

To scratch all files from a disk that begin with the letter M, you would type the following:

```
OPEN 15,8,15
PRINT#15,"S0:M*"
```

or, using the wedge:

```
@S0:M*
```

Be careful. There might be more files starting with M than you expected. Take a directory listing first (using pattern matching, of course).

Here's another example. Suppose you've been writing a BASIC program called DIS. As you write code, you save the program from time to time, creating DIS1 and DIS2. Then you start testing and correcting, saving new versions as you go, and create DIS3, DIS4, and DIS5. Finally, you're satisfied, and you save your final version as DISK/EDIT. How can you get rid of your five development programs, named DIS1 to DIS5? Easy. Scratch pattern DIS? and they will all go. DISK/EDIT will stay, since the ? character matches only a single character. Do not scratch pattern DIS* since that would definitely clobber DISK/EDIT.

But be careful. Just before you give the command to scratch pattern DIS?, take a directory with the same pattern. You might have other files called DISK or DISH that match the same pattern. So you might code:

```
LOAD "$0:DIS?"
LIST
```

or, with the wedge:

```
@$0:DIS?
```

You'll see the programs that match the name pattern. If they are exactly the ones you want, type the Scratch command; or with the wedge, you can go back and type over the dollar sign with the letter S; pressing RETURN will scratch these files.

New Patterns

There are other patterns that are less well-known. For example, a filename is a pattern; it must be matched exactly. Thus, if I have a file named HOG and I want to see that it is in the directory, and perhaps check the number of blocks, I can type:

```
LOAD "$0:HOG",8
LIST
```

or,

```
@$0:HOG
```

The only item in the directory will be file HOG (if it exists).

Let's take this a step further. Suppose I don't want to see any file details. All I need is the title of the disk, its ID, and the number of blocks free. That's easy: Just specify a file that does not exist on the disk. The directory will then consist of the title line and the blocks free information. I often ask for a directory using a filename such as 0:#$&!%. This isn't an expletive; it's just a name that I know doesn't exist on the disk so that I'll get the blocks free count.

The Lone Asterisk

You would think that a pattern consisting of only a single asterisk would mean "any file." Thus, a command such as LOAD "*",8 would bring in the first file since anything will match. That's not quite correct: The asterisk often has a special meaning.

The single asterisk sometimes means "same name as last time." It may have been Commodore's intention to allow a user to load a program, and later save it with the same name with SAVE "*",8, the asterisk meaning "same name as before." This was never implemented fully, but you can see traces of this idea in the dual disk copy command. If you have a dual disk, type:

```
@C1:*=0:PROGNAME
```

We can see that this command asks to copy a file called PROGNAME to drive 1; but what name will the new file be given? The destination name is *—which in this case means "same name." Thus, the new file will be named PROGNAME, too. It seems that it was originally Commodore's intention to allow copying to take place with pattern matching, so that C1:*=0:RA* would copy all files whose names started with RA from drive 0 to drive 1 with the same name. If you have a dual drive, try it; it almost works correctly.

So it turns out that LOAD "*",8 does not always load the first file on the disk. Sometimes it loads the same file that was previously loaded.

Specifying Type

You may specify a file type by adding an equals sign to the pattern followed by the file designation: S for Sequential, P for Program, U for User, and R for Relative types. You may also type the three-letter designation such as SEQ or PRG if you wish. Thus, 0:*=S will reference all sequential files, 0:B*=P will reference all programs whose names start with B, and 0:?=P will reference all programs with one-letter names.

Next month we'll look at a common disk error and a way to fix it. ©

C Regena

Writing An Educational Program

I'm sure you already know or have read what a "good" educational program should contain. I'd like to discuss how you actually program an educational program. I decided that the best way I could describe the process was to write a program, then provide a step-by-step explanation of what I did.

The hardest part of writing any program is deciding the topic and the type of program—drill and practice, tutorial, simulation, game, etc. I picked a very popular topic for computer programs, the Morse code, and decided to do a drill-and-practice program. Quite a few readers have requested programs for secondary school students, so next month I'll present a tutorial on a high school subject.

Memorization Quiz

A drill-and-practice program is useful for any subject that requires memorization. The usual procedure is to ask a question, then have the student input an answer. If you can avoid INPUT and use CALL KEY instead, there will be much less chance for errors or "crashing" the program. In the "Morse Code" program, the quiz will be to press the letter or number after the computer displays a code.

I decided to use the numbers from 0 to 9 and the whole alphabet in the quiz. Since each number and letter corresponds to a code, I set up the array M$ to contain the codes. M$(0) through M$(9) will hold the codes for the numbers in order from 0 through 9. The alphabet will be in M$(10) through M$(35). Since we need 36 elements for the array, line 160 dimensions M$. Lines 170–190 READ the codes for M$ from data in lines 200–250. The data items are in order—first the numbers then the alphabet—each item separated by a comma.

Dots And Dashes

I started out using periods for dots and minus signs for dashes, but decided it was too difficult to type periods with commas—too much chance for typing errors in the DATA statements. Also, the minus sign requires the SHIFT key and the period doesn't, so the typing was a little more complex. I looked on the ASCII character code chart to see what symbols I wouldn't be using in regular printing and decided to use the ampersand (&) to represent a dash and the percent sign (%) to represent a dot.

I borrowed my son's Morse code chart and converted the dots and dashes into % and & signs. These codes are in the DATA statements of lines 200–250. You may use longer DATA statements if you like (the TI accepts up to four screen lines for each numbered line), but I kept the statements shorter to make it a little easier to type and debug.

The next step was to design the graphics—the dots and dashes. The % sign represents a dot in the DATA statement codes and is redefined in line 140 using a CALL CHAR statement so that it will draw a dot on the screen. The & sign is redefined as a bar-shaped figure in line 150. When a dash is printed on the screen, it will actually be three & signs placed together.

The subroutine in lines 360–470 is the main section of coding that translates a code in M$ to the graphic representation on the screen. Looking at a code, if the symbol is % we need to draw a dot, and if the symbol is & we need to draw a dash. This process continues for the entire data, which can be from one to five dots and dashes. Line 360 instructs the computer to check from 1 to the length of the data (which will be from 1 to 5). Line 370 assigns a one-character value to A$ for every increment of the FOR-NEXT loop in line 360. This one-character value is the symbol in the Jth place of the string in the DATA statements. Lines 380–430 instruct the computer to print a dot if the symbol is % and a dash (which

is &&&) if the symbol is &. I put a space after the dot or dash to separate them slightly on the screen. You could use CALL HCHAR instead if you wish, but I used PRINT. By printing with semicolons, everything will stay on the same line and be printed right after the previous printing.

Making Some Noise

Since the TI has sound, we can use sound in our Morse code program. Besides that, real Morse code transmission is by sounds. Line 390 plays a sound for a dash, and line 420 plays a different sound for a dot. I used a sound duration of 300 for the dash and 60 for the dot. As you learn the Morse code, you'll probably want to shorten those durations. You should also try different frequencies instead of the one I chose (131) or combinations of frequencies and noise numbers to get a sound you like. Line 440 stops the sound so that dots and dashes are distinct. If you don't have this statement, dashes would run together and you wouldn't be able to tell how many dashes there should be.

Line 450 forces the loop to go to the next symbol in the code. Line 460 PRINTs to get off the present line (colon means "go to the next line" in printing) and add an extra line between codes. Line 470 returns program execution from this subroutine.

Returning To The Menu

I thought it would be nice to review the numbers and letters before having to take the quiz, so there are three sections: Numbers, Alphabet, and Press a Key. Numbers will print each number and show the corresponding Morse code. Alphabet will go through the whole alphabet in order and print each letter with its code. In Press a Key the student can press any number or letter, and the computer will print the code. In any of these sections the student can at any time press ENTER, and the demonstration will stop and the program will return to the main menu screen.

The procedure to see the codes for the numbers is in lines 560–670. Line 570 begins the FOR-NEXT loop with the counter I varying from 0 to 9 for the numbers. The number is printed (by printing I), then the subroutine at 360 is called which deciphers the code M$(I) into the dots and dashes and prints the code on the screen while playing the tones. Line 600 calls subroutine 480, which is simply a delay loop to create a slight pause between numbers. Lines 520–530 check to see if the student has pressed ENTER to return to the main menu screen and stop the numbers section.

The Alphabet section, lines 680–790 is similar to the Numbers section. This time the loop counter I varies from 10 to 35, and the codes will go in order from M$(10) to M$(35), which are the letters from A to Z. To print the letters with the codes, line 700 uses the CHR$ function. The ASCII codes of the letters are from 65 to 90. Since the loop counter I varies from 10 to 35, the ASCII codes for CHR$ are 55+I.

In the Press a Key section, the student may press a letter or number and the computer will display the code. This section could be used as a quick review for students who want to study certain letters. The student may also spell words and phrases one letter at a time to see and hear the Morse code equivalent. Lines 840–920 detect which key is pressed. If the ENTER key (K=13) is pressed, the program branches back to the main menu screen. The IF-THEN statements make sure that only a number or a letter is pressed; all other keys are ignored. The variable K holds the ASCII value of the key pressed, and lines 900 and 930 relate K to the variable I which is used to print the code M$(I).

The instructions are in lines 970–1040, and the quiz is contained in lines 1050–1490. The quiz consists of all ten numbers and 26 letters. An array N() is set up so each of the 36 elements from 0 to 35 is equal to 1. This is in lines 1050–1070. Later as one of the numbers or letters is answered correctly, N(I) will be set to zero so it cannot be chosen again. Line 1080 initializes the number of guesses G to zero for the scoring.

The quiz loop first chooses a random number (I) from 0 to 35 (line 1140). If the number has previously been answered correctly, N(I) will be zero and another number I is chosen. Lines 1160–1190 determine the correct answer L for the number I, which will be the ASCII code of the number or letter chosen. Line 1200 calls the subroutine to print and sound out the code chosen, and line 1210 increments the number of guesses.

Lines 1220–1290 detect the key the student presses; makes sure it is ENTER, a number, or a letter; and then prints the key pressed. If the key pressed is ENTER, the program branches back to the main menu and the quiz ends. Lines 1300–1390 determine if the key pressed is the correct answer. If the answer is incorrect, an "uh-oh" sound is played and the program branches back to line 1200 to display and sound the code again and wait for another answer. If the answer is correct, an arpeggio is played. After the code is answered correctly, line 1400 sets N(I) to zero so that code cannot be chosen again, and line 1410 goes to the next problem. The student must get the right answer to continue the quiz.

Quiz Variations

You can change the program to give the right

answer if the student misses. Instead of lines 1330 and 1340, print CHR$(L) or CALL HCHAR or CALL VCHAR and put L on the screen, then branch to line 1400. In this case you might want to keep a score of number correct and number incorrect. You might want to allow that missed letter or number to be shown again. Branch to line 1410 instead of 1400, and before you branch set Z=Z−1. Another way would be to GOTO 1140 instead of changing the loop counter Z and going to the NEXT Z.

If you prefer to let the student guess two or three times before the correct answer is given, set up a flag (FLAG=0) at line 1155 then at line 1340 increment the flag (FLAG=FLAG+1). You could then branch, depending on the value of FLAG, either back for another guess or to give the answer and branch to the next problem.

You might prefer to have a quiz of a certain number of codes, say 10, rather than all 10 numbers and 26 letters. Change line 1130 to FOR Z=1 TO 10. Using lines 1150 and 1400 will still prevent the quiz from choosing the same number or letter more than once.

Another idea would be to have an infinite quiz. Take off the FOR-NEXT loop, lines 1130 and 1410. Also, you won't need lines 1150 and 1400 (and 1050–1070) because the numbers and letters can keep being chosen. Now the quiz keeps going until the student presses ENTER to return to the main menu screen.

In this type of quiz you may want to make sure the code is not the same as the previous one. We can use a variable P1 for previous l chosen, and add these two lines:

```
1150 IF PI=I THEN 1140
1155 PI=I
```

You can change the Numbers and Alphabet sections to fit your needs also. To change the delay time between codes, change the upper limit in line 480. Instead of 200, put your own number; a larger number will be a longer delay. Instead of using a delay between numbers and letters, you can have the student press any key to continue, or press the appropriate number or letter. You can change the following lines:

```
650 IF K<>I+48 THEN 610
655 NEXT I
770 IF K<>I+55 THEN 730
775 NEXT I
```

The program is flexible enough that you can change it to do exactly what you want it to do. You can even change the graphics and make it a quiz to learn Braille, or sign language, or some other type of code. You can use words instead of the alphabet and make a quiz for reviewing a foreign language, or perhaps vocabulary words.

Structuring Your Programs

A couple of readers have suggested that I include flowcharts with my programs. My secret is that I haven't touched a flowchart since it was required in my college FORTRAN class years ago. In answer to your questions of how I plan a program, I just sit down at the computer and start typing. With this program, I got to line 350 and typed

```
350 ON K-48 GOTO 1000,2000,3000,400
    0,5000
```

then worked on a section at a time, not necessarily in order. The Numbers section started with line 1000, Alphabet with line 2000, Press a Key with line 3000, the quiz with line 4000, and 5000 was END.

As I realized I needed subroutines, I numbered them 400, 600, and 700, making sure l didn't get to line 1000. On the TI it doesn't really matter where you put the subroutines; you can put them all at the end if you prefer. Anyway, after everything was running properly and each section was tested, l used the RES command to get all the line numbers to look nice. Each programmer has his or her own way of planning, and there's really no right way or wrong way. I say if it works, you're successful.

If you wish to save typing effort, you may obtain a copy of Morse Code by sending $3, a blank cassette or disk, and a stamped, self-addressed mailer to:

C. Regena
P.O. Box 1502
Cedar City, UT 84720

Be sure to specify the title and that you need the TI version.

Morse Code

```
100 CALL CLEAR
110 PRINT TAB(7);"**************"
120 PRINT TAB(7);"* MORSE CODE *"
130 PRINT TAB(7);"**************"::
    ::
140 CALL CHAR(37,"3C7EFFFFFFF7E3C"
    )
150 CALL CHAR(38,"00FFFFFFFFFFFF")
160 DIM M$(35),N(35)
170 FOR A=0 TO 35
180 READ M$(A)
190 NEXT A
200 DATA &&&&&,%&&&&,%%&&&,%%%&&,%%
    %%&
210 DATA %%%%%,&%%%%,&&%%%,&&&%%,&&
    &&%
220 DATA %&,&%%%,&%&%,&%%,%,%%&%,&&
    %
230 DATA %%%%,%%,%&&&,&%&,%&%%,&&,&
    %
240 DATA &&&,%&&%,&&%&,%&%,%%%,&,%%
    &
250 DATA %%%&,%&&,&%%&,&%&&,&&%%
```

```
260 PRINT "CHOOSE:"
270 PRINT :TAB(5);"1  NUMBERS"
280 PRINT :TAB(5);"2  ALPHABET"
290 PRINT :TAB(5);"3  PRESS A KEY"
300 PRINT :TAB(5);"4  QUIZ"
310 PRINT :TAB(5);"5  END PROGRAM":
    :::::
320 CALL KEY(0,K,S)
330 IF (K<49)+(K>53)THEN 320
340 CALL CLEAR
350 ON K-48 GOTO 560,680,800,970,15
    00
360 FOR J=1 TO LEN(M$(I))
370 A$=SEG$(M$(I),J,1)
380 IF A$="%" THEN 420
390 CALL SOUND(300,131,0)
400 PRINT "&&& ";
410 GOTO 440
420 CALL SOUND(60,131,0)
430 PRINT "% ";
440 CALL SOUND(1,9999,30)
450 NEXT J
460 PRINT ::
470 RETURN
480 FOR D=1 TO 200
490 NEXT D
500 RETURN
510 PRINT :"PRESS <ENTER>";
520 CALL KEY(0,K,S)
530 IF K<>13 THEN 520
540 CALL CLEAR
550 RETURN
560 PRINT TAB(7);"** NUMBERS **"::
570 FOR I=0 TO 9
580 PRINT TAB(4);I;"  ";
590 GOSUB 360
600 GOSUB 480
610 CALL KEY(0,K,S)
620 IF K<>13 THEN 650
630 CALL CLEAR
640 GOTO 260
650 NEXT I
660 GOSUB 510
670 GOTO 260
680 PRINT TAB(6);"** ALPHABET **"::
    :
690 FOR I=10 TO 35
700 PRINT TAB(4);CHR$(55+I);"  ";
710 GOSUB 360
720 GOSUB 480
730 CALL KEY(0,K,S)
740 IF K<>13 THEN 770
750 CALL CLEAR
760 GOTO 260
770 NEXT I
780 GOSUB 510
790 GOTO 260
800 PRINT "PRESS A LETTER OR A NUMB
    ER."
810 PRINT :"ITS CODE WILL BE GIVEN.
    "
820 PRINT :"TO GET BACK TO THE MAIN
    "
830 PRINT :"MENU SCREEN, PRESS <ENT
    ER>.":::
840 CALL KEY(0,K,S)
850 IF K<>13 THEN 880
860 CALL CLEAR
870 GOTO 260
880 IF K<48 THEN 840
890 IF K>57 THEN 920
900 I=K-48
910 GOTO 940
920 IF (K<65)+(K>90)THEN 840
930 I=K-55
940 PRINT CHR$(K);"  ";
950 GOSUB 360
960 GOTO 840
970 PRINT "** MORSE CODE QUIZ **"
980 PRINT ::"YOU WILL HEAR AND SEE
    A"
990 PRINT :"MORSE CODE FOR ONE OF T
    HE"
1000 PRINT :"LETTERS OR NUMBERS."
1010 PRINT :"TYPE THE TRANSLATION."
1020 PRINT :"PRESS <ENTER> TO END T
     HE"
1030 PRINT :"QUIZ AND RETURN TO THE
     "
1040 PRINT :"MAIN MENU SCREEN."
1050 FOR I=0 TO 35
1060 N(I)=1
1070 NEXT I
1080 G=0
1090 PRINT ::"PRESS <ENTER> TO STAR
     T.":::
1100 CALL KEY(0,K,S)
1110 IF S<1 THEN 1100
1120 RANDOMIZE
1130 FOR Z=0 TO 35
1140 I=INT(36*RND)
1150 IF N(I)=0 THEN 1140
1160 IF I>9 THEN 1190
1170 L=I+48
1180 GOTO 1200
1190 L=I+55
1200 GOSUB 360
1210 G=G+1
1220 CALL KEY(0,K,S)
1230 IF K<>13 THEN 1260
1240 CALL CLEAR
1250 GOTO 260
1260 IF K<48 THEN 1220
1270 IF K<58 THEN 1290
1280 IF (K<65)+(K>90)THEN 1220
1290 CALL HCHAR(22,28,K)
1300 IF K=L THEN 1350
1310 CALL SOUND(80,330,2)
1320 CALL SOUND(80,262,2)
1330 GOSUB 480
1340 GOTO 1200
1350 CALL SOUND(100,262,2)
1360 CALL SOUND(100,330,2)
1370 CALL SOUND(100,392,2)
1380 CALL SOUND(200,524,2)
1390 CALL SOUND(1,9999,30)
1400 N(I)=0
1410 NEXT Z
1420 PRINT :::"OUT OF 36 NUMBERS AN
     D"
1430 PRINT "LETTERS, YOUR NUMBER OF
     "
1440 PRINT "GUESSES WAS";G:::
1450 FOR I=1 TO 25
1460 CALL SOUND(-99,INT(400*RND)+50
     0,2)
1470 NEXT I
1480 GOSUB 510
1490 GOTO 260
1500 END
```

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64 EXPLORER

Larry Isaacs

This month let's discuss a few more things concerning the line-drawing and character-drawing routines presented in the last couple of columns. Some of you may have noted that the character-drawing routines did not support the multicolor mode. This could be done with some additional time and effort. However, because of the increased complexities of handling multicolor mode, there probably won't be room for the routines in the $C000 to $C7FF region of RAM where the other routines were located.

Multiuse Vector Bytes

There were some other things which were not implemented as well. First, vector byte strings were provided only for the uppercase character set. The remaining characters weren't implemented due to the space they would require. You could implement the remaining characters yourself, or even create an entire character set of your own design. Also, you are not restricted to drawing characters. The vector byte strings could be used to draw almost any design.

If you have studied the machine language listing for the character-drawing routines, you may have noticed there was some provision made for additional special function vector bytes. One I had in mind, but didn't get around to implementing, was a "clear character cell" special function code. This would clear a character cell of a specified size. The function would be useful if you wanted to draw characters on top of some other design. Another useful function would be contour fill function—that is, fill the area inside a boundary. With this, large solid characters could be made much more easily. Unfortunately, I doubt there is enough room in the code to have such a routine. Perhaps we can discuss contour filling in a future article.

As you might guess, there are lots of other things which could be implemented. Unfortunately, there isn't enough room to implement them all. This is where the machine language source code listing should come in handy. You can combine routines from various sources to construct the set of routines you require.

Easy To Understand

I hope the comments provided in the source code are sufficient to make most of the routines understandable. The thoroughness of the comments is not consistent throughout the source code. The variation is largely due to an effort to keep the source code from growing too large.

Having good comments in a program can be extremely useful. Unfortunately, there are a couple of factors which tend to discourage commenting. The first factor is that it makes the source code longer. With the speed of the 1541 disk drive, the extra size can noticeably affect the length of time it takes to edit or assemble the source file. The second factor is that it takes extra time to write the comments. Usually, writing the comments will be less interesting than writing the program.

However, if the machine language you plan to write will be of some importance, I highly recommend thoroughly commenting the program. You can use comments to understand how the program was intended to work after you've forgotten. You'd be surprised how fast you can forget.

Comment Fields

There are two basic places to put your comments. One is to the side of the machine language instructions, on the same line as the instructions. The other is between routines, where the comments would document the routine which follows. It is here that the extra effort commenting pays off the best. Ideally, the comments should include a description of what the routine is supposed to do, plus the entry and exit conditions that apply. This would allow you to use the routine, once it is written, without having to study the routine itself to determine what it does. In the long run, such comments can actually save a lot of time. Especially if someone else has to make use of your source code. In the source code I've provided so far, most of the time I've included the entry and exit conditions, but have omitted the description to conserve space.

Program 2 and Program 3 which follow are continuations of last month's column on drawing characters to the bitmap. They facilitate the drawing of letters to a hi-res screen.

Refer to the "Automatic Proofreader" article before typing these programs in.

Program 2:
Data For Character Routines

```
1 READ LN,SA,EA:LN=LN+30                    :rem 146
10 FOR I=0 TO EA-SA                         :rem 232
20 READ BY:POKE SA+I,BY:SUM=SUM+BY
                                            :rem 120
30 IF INT((I+1)/8)*8<>(I+1) THEN 60
                                            :rem 242
40 READ CS:IF CS<>SUM THEN 90               :rem 124
50 SUM=0:LN=LN+10                           :rem 254
60 NEXT                                     :rem 165
70 IF INT(I/8)*8<>I THEN READ CS:IF CS<>S
   UM THEN 90                               :rem 78
80 PRINT "SUCCESSFUL LOAD":END              :rem 106
90 PRINT "ERROR IN LINE";LN:END             :rem 105
500 DATA 500                                :rem 68
510 DATA 50176                              :rem 179
520 DATA 51090                              :rem 176
530 DATA 76,220,197,76,230,197,76,99,1171
                                            :rem 0
540 DATA 199,76,109,199,76,138,199,76,107
    2                                       :rem 67
550 DATA 24,196,76,24,196,76,24,196,812
                                            :rem 155
560 DATA 96,0,208,0,0,0,0,0,304             :rem 213
570 DATA 0,0,0,0,0,0,0,0,0                  :rem 198
580 DATA 0,0,0,0,0,0,0,0,0                  :rem 199
590 DATA 0,0,0,0,0,0,0,32,32                :rem 50
600 DATA 253,174,32,138,173,32,247,183,12
    32                                      :rem 72
610 DATA 165,101,164,100,96,32,253,174,10
    85                                      :rem 67
620 DATA 32,158,173,36,13,48,3,76,539
                                            :rem 42
630 DATA 240,192,160,0,177,100,141,30,104
    0                                       :rem 250
640 DATA 196,200,177,100,133,20,200,177,1
    203                                     :rem 102
650 DATA 100,133,21,76,163,182,72,162,909
                                            :rem 230
660 DATA 0,201,32,144,5,233,32,232,879
                                            :rem 72
670 DATA 208,247,104,24,125,121,196,170,1
    195                                     :rem 125
680 DATA 96,128,0,192,224,192,192,128,115
    2                                       :rem 34
690 DATA 128,133,253,173,14,220,41,254,12
    16                                      :rem 67
700 DATA 141,14,220,165,1,41,251,133,966
                                            :rem 166
710 DATA 1,169,0,6,253,42,6,253,730
                                            :rem 179
720 DATA 42,6,253,42,133,254,24,173,927
                                            :rem 132
730 DATA 25,196,101,253,133,253,173,26,11
    60                                      :rem 67
740 DATA 196,101,254,133,254,162,0,160,12
    60                                      :rem 61
750 DATA 7,177,253,153,32,196,138,153,110
    9                                       :rem 36
760 DATA 41,196,136,16,244,165,1,9,808
                                            :rem 93
770 DATA 4,133,1,173,14,220,9,1,555
                                            :rem 177
780 DATA 141,14,220,96,160,7,162,7,807
                                            :rem 84
790 DATA 30,41,196,106,202,16,249,153,993
                                            :rem 241
800 DATA 32,196,136,16,241,96,169,7,893
                                            :rem 153
810 DATA 133,251,162,0,160,7,30,41,784
                                            :rem 68
820 DATA 196,106,136,16,249,164,251,153,1
    271                                     :rem 130
830 DATA 32,196,232,198,251,16,237,96,125
    8                                       :rem 45
840 DATA 160,7,162,7,94,41,196,42,709
                                            :rem 44
850 DATA 202,16,249,153,32,196,136,16,100
    0                                       :rem 17
860 DATA 241,96,172,29,196,208,1,96,1039
                                            :rem 202
870 DATA 162,7,189,32,196,157,41,196,980
                                            :rem 211
880 DATA 202,16,247,136,208,3,76,204,1092
                                            :rem 232
890 DATA 196,136,208,3,76,222,196,76,1113
                                            :rem 248
900 DATA 248,196,160,8,169,0,153,41,975
                                            :rem 147
910 DATA 196,136,16,250,169,255,141,40,12
    03                                      :rem 72
920 DATA 196,138,240,15,168,162,8,94,1021
                                            :rem 238
930 DATA 32,196,126,41,196,202,16,247,105
    6                                       :rem 29
940 DATA 136,208,242,96,32,97,192,173,117
    6                                       :rem 45
950 DATA 32,192,41,7,133,253,162,0,820
                                            :rem 73
960 DATA 160,0,177,251,45,49,196,29,907
                                            :rem 152
970 DATA 32,196,145,251,160,8,177,251,122
    0                                       :rem 28
980 DATA 45,40,196,29,41,196,145,251,943
                                            :rem 202
990 DATA 232,224,8,240,31,198,253,48,1234
                                            :rem 239
1000 DATA 8,230,251,208,219,230,252,208,1
     606                                    :rem 107
1010 DATA 215,169,7,133,253,24,165,251,12
     17                                     :rem 65
1020 DATA 105,57,133,251,165,252,105,1,10
     69                                     :rem 58
1030 DATA 133,252,208,196,76,114,192,140,
     1311                                   :rem 162
1040 DATA 31,196,32,102,196,32,129,196,91
     4                                      :rem 26
1050 DATA 32,10,197,32,171,193,32,42,709
                                            :rem 173
1060 DATA 197,32,76,197,24,169,8,160,863
                                            :rem 203
1070 DATA 0,174,29,196,240,12,202,240,109
     3                                      :rem 9
1080 DATA 25,169,248,160,255,202,240,2,13
     01                                     :rem 60
1090 DATA 208,16,109,30,192,141,30,192,91
     8                                      :rem 21
1100 DATA 152,109,31,192,141,31,192,76,92
     4                                      :rem 16
```

```
1110 DATA 216,197,109,32,192,141,32,192,1
     111                                :rem 109
1120 DATA 172,31,196,96,32,55,196,141,919
                                        :rem 243
1130 DATA 25,196,140,26,196,96,32,69,780
                                        :rem 197
1140 DATA 196,36,13,48,3,76,151,197,720
                                        :rem 138
1150 DATA 173,30,196,240,13,160,0,177,989
                                        :rem 233
1160 DATA 20,32,151,197,200,204,30,196,10
     30                                 :rem 48
1170 DATA 144,245,96,41,127,10,168,173,10
     04                                 :rem 69
1180 DATA 27,196,133,251,173,28,196,133,1
     137                                :rem 132
1190 DATA 252,177,251,141,50,196,200,177,
     1444                               :rem 174
1200 DATA 251,141,51,196,96,173,50,196,11
     54                                 :rem 75
1210 DATA 133,251,173,51,196,133,252,160,
     1349                               :rem 166
1220 DATA 0,177,251,72,238,50,196,208,119
     2                                  :rem 24
1230 DATA 3,238,51,196,104,201,143,240,11
     76                                 :rem 59
1240 DATA 1,24,96,72,41,15,201,8,458
                                        :rem 231
1250 DATA 144,2,9,240,141,54,196,169,955
                                        :rem 190
1260 DATA 0,141,53,196,104,74,74,74,716
                                        :rem 133
1270 DATA 74,201,8,144,7,9,240,162,845
                                        :rem 83
1280 DATA 255,142,53,196,141,52,196,96,11
     31                                 :rem 82
1290 DATA 56,169,0,237,52,196,141,52,903
                                        :rem 189
1300 DATA 196,169,0,237,53,196,141,53,104
     5                                  :rem 26
1310 DATA 196,96,56,169,0,237,54,196,1004
                                        :rem 243
1320 DATA 141,54,196,96,169,0,141,53,850
                                        :rem 185
1330 DATA 196,173,52,196,174,54,196,141,1
     182                                :rem 138
1340 DATA 54,196,142,52,196,16,5,169,830
                                        :rem 192
1350 DATA 255,141,53,196,96,174,29,196,11
     40                                 :rem 89
1360 DATA 208,1,96,202,208,6,32,124,877
                                        :rem 132
1370 DATA 198,76,96,198,202,208,6,32,1016
                                        :rem 246
1380 DATA 96,198,76,114,198,32,124,198,10
     36                                 :rem 100
1390 DATA 76,114,198,32,149,198,24,173,96
     4                                  :rem 53
1400 DATA 32,192,109,54,196,141,36,192,95
     2                                  :rem 30
1410 DATA 24,173,30,192,109,52,196,141,91
     7                                  :rem 24
1420 DATA 34,192,173,31,192,109,53,196,98
     0                                  :rem 34
1430 DATA 141,35,192,96,169,0,141,53,827
                                        :rem 186
1440 DATA 196,32,29,198,141,52,196,201,10
     45                                 :rem 79
1450 DATA 0,16,5,169,255,141,53,196,835
                                        :rem 138
1460 DATA 32,29,198,141,54,196,76,179,905
                                        :rem 2
1470 DATA 198,140,31,196,32,3,198,32,830
                                        :rem 187
1480 DATA 29,198,176,99,32,59,198,201,992
                                        :rem 16
1490 DATA 248,240,9,32,179,198,32,195,113
     3                                  :rem 41
1500 DATA 194,76,247,198,174,54,196,208,1
     347                                :rem 152
1510 DATA 15,32,29,198,32,59,198,32,595
                                        :rem 150
1520 DATA 179,198,32,159,193,76,247,198,1
     282                                :rem 159
1530 DATA 202,208,9,32,212,198,32,195,108
     8                                  :rem 27
1540 DATA 194,76,247,198,202,208,9,32,116
     6                                  :rem 40
1550 DATA 212,198,32,159,193,76,247,198,1
     315                                :rem 147
1560 DATA 202,208,6,32,24,196,76,247,991
                                        :rem 194
1570 DATA 198,202,208,6,32,24,196,76,942
                                        :rem 196
1580 DATA 247,198,202,208,6,32,24,196,111
     3                                  :rem 28
1590 DATA 76,247,198,202,208,6,32,24,993
                                        :rem 201
1600 DATA 196,76,247,198,76,247,198,172,1
     410                                :rem 153
1610 DATA 31,196,96,32,55,196,141,27,774
                                        :rem 197
1620 DATA 196,140,28,196,96,32,69,196,953
                                         :rem 6
1630 DATA 36,13,48,3,76,241,198,173,788
                                        :rem 152
1640 DATA 30,196,240,13,160,0,177,20,836
                                        :rem 171
1650 DATA 32,241,198,200,204,30,196,144,1
     245                                :rem 116
1660 DATA 245,96,32,234,192,41,3,141,984
                                        :rem 190
1670 DATA 29,196,96,321                 :rem 124
```

Program 3:
Illustration Of Character Routines

```
10 REM DRAW CHARACTERS IN BIT-MAP:rem 212
20 POKE 56,156:CLR                :rem 223
30 CT=PEEK(56)*256+PEEK(55):REM CHAR DATA
    PTR                            :rem 54
40 J1=49152:REM DRAWING JUMP TABLE
                                   :rem 239
50 J2=50176:REM CHAR. JUMP TABLE   :rem 47
60 GOTO 1000                       :rem 96
1000 REM MAIN ROUTINE              :rem 240
1010 GOSUB 10000:SYS J2+6,CT       :rem 12
1020 SYS J1:SYS J1+6,0:SYS J1+9,6,14
                                   :rem 185
1030 SYS J1+12,10,180:REM MOVE     :rem 115
1040 SYS J2+3,"EXAMPLE USE OF PUT "
                                   :rem 149
1050 SYS J2+3,"CHARACTER ROUTINE."
                                   :rem 240
1060 SYS J1+12,10,160:REM MOVE     :rem 116
1070 FOR CH=32 TO 63               :rem 232
1080 SYS J2+3,CH:NEXT              :rem 210
1090 SYS J1+12,257,140             :rem 93
```

```
1100 SYS J2+12,2:REM ROTATE 180 DEG.
                                    :rem 173
1110 FOR CH=64 TO 95                :rem 237
1120 SYS J2+3,CH:NEXT               :rem 205
1130 SYS J2+12,0:REM NO ROTATION     :rem 85
2000 SYS J1+12,10,80:REM MOVE        :rem 64
2010 SYS J2+9,"EXAMPLE USE OF DRAW "
                                    :rem 206
2020 SYS J2+9,"CHARACTER ROUTINE":rem 198
2030 SYS J1+12,10,60:REM MOVE        :rem 65
2040 FOR CH=64 TO 90                :rem 235
2050 SYS J2+9,CH:NEXT               :rem 214
2060 SYS J1+12,217,40:REM MOVE      :rem 123
2070 SYS J2+12,2:REM ROTATE 180 DEG.
                                    :rem 180
2080 FOR CH=90 TO 64 STEP -1        :rem 137
2090 SYS J2+9,CH:NEXT               :rem 218
2100 SYS J2+12,0:REM NO ROTATION     :rem 83
9000 GET Z$:IF Z$="" THEN 9000      :rem 231
9010 SYS J1+3                       :rem 162
9020 END                            :rem 162
10000 REM LOAD CHAR. VB DATA        :rem 243
10010 C=0:PT=CT+256:REM INIT POINTER
                                    :rem 143
10020 READ CH:IF CH<0 THEN RETURN:rem 105
10030 HB=INT(PT/256):LB=PT-HB*256:rem 142
10040 POKE CT+CH*2,LB:POKE CT+CH*2+1,HB
                                    :rem 171
10050 GOSUB 10100:REM LOAD VB DATA:rem 88
10060 GOTO 10020                     :rem 35
10100 REM LOAD CHAR. DATA AT PT     :rem 149
10110 READ VB                       :rem 167
```


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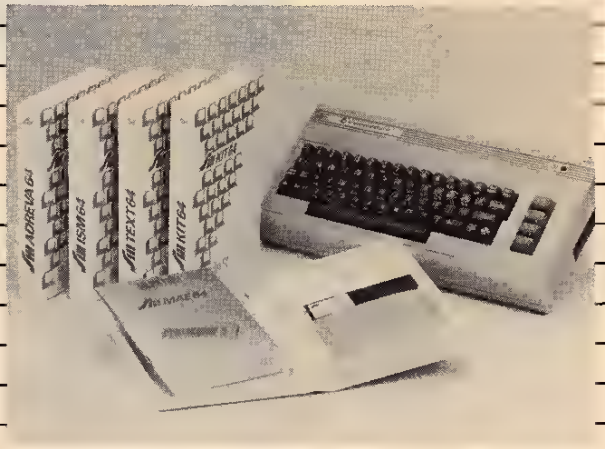

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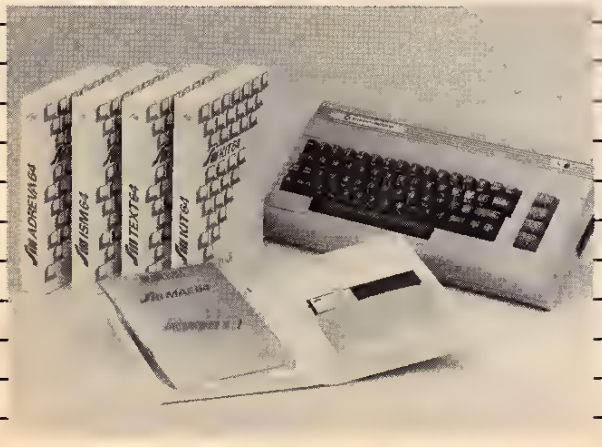

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```
10120 IF C>0 THEN C=C-1:GOTO 10180
                                    :rem 241
10130 IF ABS(VB)>7 THEN 10160       :rem 223
10140 READ DY:VB=(VB*16+(DYAND15))
                                    :rem 138
10150 GOTO 10180                     :rem 42
10160 IF VB=143 THEN 10190           :rem 30
10170 IF VB<>128 THEN C=2            :rem 22
10180 POKE PT,VBAND255:PT=PT+1:GOTO 10110
                                    :rem 129
10190 POKE PT,VBAND255:PT=PT+1:RETURN
                                     :rem 54
11100 REM ADD CHARACTER DATA FROM PROGRAM
       1 IN LAST MONTH'S ISSUE      :rem 24
```

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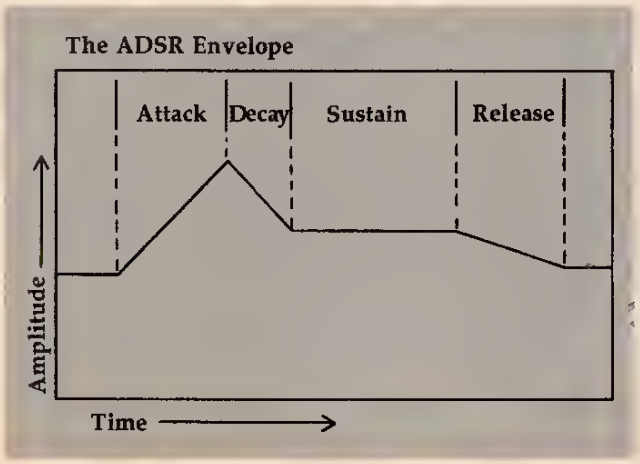
SYSound

Mike Steed

The Commodore 64 has an amazing sound chip, and anyone who has heard it knows this. However, anyone who has tried to program it may have been surprised or discouraged, because everything had to be done with POKEs. That is, until now. "SYSound" will make creating sounds much easier, using absolutely no POKEs at all. Also included is an example program to show how easy programming 64 music can be.

Type in Program 1 and be sure to save a copy before running it. Program 1 loads in SYSound, which is a machine language program, and one typing mistake can crash SYSound when you use it. You may wish to save a copy of just the machine language once it's loaded, if you have a machine language monitor. Program 1 will specify the start and end addresses.

To use SYSound, all you need to do is type SYS 49152 followed by any of several possible parameters, each separated by a comma. The number 49152 could (and probably should) be put into a variable, such as S or SOUND.



A list of possible parameters for the SYS statement and their meanings follows:

- V*x*, where *x* is the voice number used for the note (one, two, or three). More than one voice may be used at the same time.
- A*x*, where *x* is the attack rate of the note. This is the time it takes the sound to reach its highest volume. The value of *x* must be between 0 and 15; the larger the number, the more time it takes. (See the figure for a further description of attack, decay, sustain, and release.)
- D*x*, where *x* is the decay rate of the note (0–15). This is the time it takes the sound to soften to the sustain volume.
- S*x*, where *x* is the sustain level of the note (0–15). The sound remains at this volume until the release starts.
- R*x*, where *x* is the release rate of the note (0–15). The release rate is the time it takes the sound to drop from the sustain volume to silence.
- W*y*[*x*], where *y* is a letter representing the waveform used for the sound. This can be N (noise), S (sawtooth), T (triangle), or P (pulse). If the pulse waveform is chosen, then a pulse rate *x* (0–4095) must be entered after the waveform letter, such as WP2048 for a square wave.
- F*x*, where *x* is the frequency of the note (0–65535). Higher frequencies will produce higher notes.
- L*x*, where *x* is the volume (loudness) of the note (0–15). Note that this is the overall volume, so all the voices will be affected by this setting.
- C clears the sound chip. This is equivalent to the following in BASIC:

```
10 S=54272:FOR I=0 TO 24:POKE S+I,0:NEXT
```

Once a parameter has been entered, it need

not be entered the next time the routine is used. For example, if all your sound effects are going to be done with voice 1, at volume 15, with the sawtooth waveform, attack 0, decay 9, and sustain and release 0, you could set all these at the beginning of your program:

```
10 S=49152:SYS S,C,V1,L15,WS,D9
```

(All parameters default to zero initially, so A, S, and R needn't be entered.) Then all that would need to be done to play a note would be:

```
20 SYS S,F5000
```

(Any valid numeric expression may be used after the parameter letter.) Also, if a parameter is entered more than once, only the last case will be considered. For example, SYS S,WS,WT,A0,A6 is effectively the same as SYS S,WT,A6.

Program 2 provides an example of SYSound in action, and shows how much simpler music programming can be accomplished.

If you would rather not type all those DATA statements, I will send you a copy of the program. Send a stamped, self-addressed mailer, a blank tape or disk (1540/1541), and $3 to:

Mike Steed
712 W. 1280 S.
Provo, UT 84601

Program 1: SYSound

Refer to the "Automatic Proofreader" article before typing this program in.

```
100 DATA 32,121,0,208,3,76          :rem 234
110 DATA 241,192,201,44,240,3       :rem 127
120 DATA 76,67,193,32,115,0          :rem 44
130 DATA 162,8,221,76,193,240       :rem 144
140 DATA 6,202,16,248,76,67          :rem 52
150 DATA 193,138,10,170,189,85      :rem 205
160 DATA 193,133,251,189,86,193       :rem 6
170 DATA 133,252,32,50,192,76       :rem 145
180 DATA 0,192,108,251,0,32          :rem 33
190 DATA 55,193,201,1,144,4          :rem 40
200 DATA 201,4,144,3,76,72          :rem 241
210 DATA 193,202,142,114,193,96     :rem 243
220 DATA 32,55,193,10,10,10          :rem 25
230 DATA 10,141,123,193,173,120     :rem 227
240 DATA 193,41,15,13,123,193       :rem 139
250 DATA 141,120,193,96,32,55       :rem 145
260 DATA 193,141,123,193,173,120     :rem 34
270 DATA 193,41,240,13,123,193      :rem 190
280 DATA 141,120,193,96,32,55       :rem 148
290 DATA 193,10,10,10,10,141         :rem 72
300 DATA 123,193,173,121,193,41     :rem 237
310 DATA 15,13,123,193,141,121      :rem 177
320 DATA 193,96,32,55,193,141       :rem 153
330 DATA 123,193,173,121,193,41     :rem 240
340 DATA 240,13,123,193,141,121     :rem 228
350 DATA 193,96,32,115,0,162         :rem 95
360 DATA 3,221,103,193,240,6         :rem 84
370 DATA 202,16,248,76,67,193       :rem 160
380 DATA 224,1,240,6,32,115          :rem 34
390 DATA 0,76,196,192,32,44          :rem 56
400 DATA 193,192,16,144,3,76         :rem 99
410 DATA 72,193,142,117,193,140      :rem 243
420 DATA 118,193,162,1,189,107       :rem 199
430 DATA 193,141,119,193,96,32       :rem 204
440 DATA 44,193,142,115,193,140      :rem 243
450 DATA 116,193,96,32,55,193        :rem 159
460 DATA 141,122,193,96,169,0        :rem 151
470 DATA 162,24,157,0,212,202        :rem 134
480 DATA 16,250,169,0,141,115        :rem 141
490 DATA 193,141,116,193,76,115      :rem 255
500 DATA 0,173,115,193,208,5          :rem 89
510 DATA 173,116,193,240,37,174      :rem 248
520 DATA 114,193,189,111,193,133      :rem 41
530 DATA 251,169,212,133,252,160      :rem 34
540 DATA 6,185,115,193,145,251       :rem 201
550 DATA 136,16,248,160,4,173        :rem 149
560 DATA 119,193,9,1,145,251         :rem 101
570 DATA 173,122,193,141,24,212      :rem 240
580 DATA 96,165,122,208,2,198        :rem 161
590 DATA 123,198,122,76,121,0        :rem 146
600 DATA 32,166,173,32,247,183       :rem 199
610 DATA 166,20,164,21,96,32          :rem 94
620 DATA 44,193,152,208,11,224       :rem 191
630 DATA 16,176,7,138,96,162         :rem 111
640 DATA 11,76,58,164,162,14         :rem 101
650 DATA 208,249,86,65,68,83         :rem 124
660 DATA 82,87,70,76,67,53            :rem 20
670 DATA 192,72,192,94,192,112       :rem 209
680 DATA 192,134,192,152,192,203      :rem 45
690 DATA 192,213,192,220,192,78        :rem 2
700 DATA 80,83,84,128,64,32           :rem 54
710 DATA 16,0,7,14,0,0                :rem 33
720 DATA 0,0,0,0,0,0                 :rem 175
730 DATA 0,0                          :rem 64
740 FORI=49152TO49531:READJ:POKEI,J:K=K+J
    :NEXT                            :rem 121
750 IFK<>44621THENPRINT"ERROR IN DATA STA
    TEMENTS":STOP                    :rem 180
760 PRINT"{CLR}{3 DOWN}SYS SOUND{DOWN}
    {9 LEFT}[9 T]":Q$=CHR$(34)       :rem 178
770 PRINT"TO SAVE IN MONITOR:":PRINT"
    {DOWN}.S "Q$"SYS SOUND"Q$",01,C000,C1
    7C                                :rem 85
780 PRINTSPC(15)"↑↑":PRINTSPC(15)"{DOWN}0
    1 FOR TAPE,":PRINTSPC(15)"08 FOR DISK
                                      :rem 32
```

Program 2: Sample Program Using SYSound

Refer to the "Automatic Proofreader" article before typing this program in.

```
120 S=49152:SYS S,C,L15:T=TIME    :rem 251
130 READ D:IF D=0 THEN SYS S,C:END
                                  :rem 111
140 READ F1,F2,F3                 :rem 113
150 SYS S,V1,F(F1),WT,A0,D9,S0, R0:rem 79
160 SYS S,V2,F(F2),WS,A2,D4,S2, R2:rem 82
170 SYS S,V3,F(F3),WT,A1,D2,S10,R10
                                  :rem 177
180 T=T+10*D                      :rem 120
190 IF T>TIME GOTO 190            :rem 189
200 GOTO 130                       :rem 95
300 DATA 1,13153,0,0              :rem 191
310 DATA 1,11060,0,0              :rem 187
320 DATA 2,8779,5530,2195         :rem 226
330 DATA 2,8779,6577,0             :rem 78
340 DATA 1,8779,4389,1644         :rem 236
350 DATA 1,9854,0,0               :rem 161
360 DATA 1,11060,6577,0           :rem 105
370 DATA 1,11718,0,0              :rem 203
400 DATA 2,13153,5530,2195        :rem 255
410 DATA 2,13153,6577,0           :rem 107
```

```
420 DATA 2,13153,4389,2463          :rem 10
430 DATA 2,11060,6577,2765          :rem 12
440 DATA 2,14764,5859,2930          :rem 23
450 DATA 2,14764,8779,0            :rem 126
460 DATA 2,14764,7382,2195          :rem 21
470 DATA 1,0,8779,0                :rem 169
480 DATA 1,13153,0,0               :rem 200
500 DATA 2,14764,5859,2930          :rem 20
510 DATA 1,0,8779,0                :rem 164
520 DATA 1,13153,0,0               :rem 195
530 DATA 1,14764,7382,2765          :rem 21
540 DATA 1,16572,0,0               :rem 205
550 DATA 1,17557,8779,2463          :rem 32
560 DATA 1,19708,0,0               :rem 211
600 DATA 2,22121,5530,2195         :rem 252
610 DATA 2,0,6577,0                :rem 160
620 DATA 2,0,4389,1644              :rem 63
630 DATA 1,17557,6577,0            :rem 122
640 DATA 1,13153,0,0               :rem 198
650 DATA 2,17557,5530,2195          :rem 18
660 DATA 2,0,6577,0                :rem 165
670 DATA 2,0,4389,2071              :rem 63
680 DATA 1,13153,6577,1845          :rem 21
690 DATA 1,11060,0,0               :rem 198
700 DATA 2,13153,5859,1644          :rem 14
710 DATA 2,0,6577,0                :rem 161
720 DATA 2,0,4927,2463              :rem 62
730 DATA 1,9854,6577,0              :rem 76
740 DATA 1,11108,0,0               :rem 197
750 DATA 2,8779,5530,2195          :rem 233
760 DATA 2,0,6577,1644              :rem 69
770 DATA 2,0,5530,1097              :rem 60
780 DATA 2,0,0,0                   :rem 255
790 DATA 0                        :rem 234 ©
```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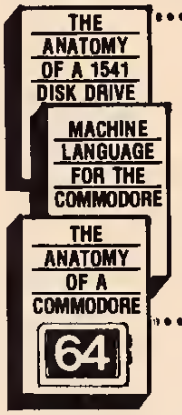

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Musical TI Keyboard

Randal J Reifsnider

The TI music chip has long been regarded as an excellent sound chip, but few programs have yet demonstrated its capabilities. "Musical TI Keyboard" changes all that by turning your TI's keys into simulated piano keys.

In the book *Beginner's BASIC* that comes with the TI-99/4A computer, there is a short demonstration program illustrating how you can use the computer's keyboard to make musical tones. When you run this program and press the A key, the musical tone A will sound. The tone will continue as long as you hold down the key, with a slight gap of silence between repetitions of the tone. This sounds like a musical machine gun. It is an interesting program, but very limited. Since it uses only seven letters of the alphabet to represent musical notes, you could play only seven notes on the computer in this fashion (A through G, with no sharps or flats).

Also, if you play the piano and are familiar with its keyboard arrangement, you'll find that looking for letters feels unnatural and difficult. Hence, "Musical TI Keyboard," which makes the computer's keyboard more closely resemble that of a piano.

This program first READs frequency values from DATA statements into an array, then mathematically converts the ASCII code returned by the CALL KEY statement, and uses that value in the CALL SOUND statement to locate the corresponding frequency value within the array. The figure shows the arrangement of the keyboard. Since not all the keys are used, the program includes a check to silence any unwanted keys. ASCII code numbers of silenced keys which fall within the array are assigned a DATA value of 1 as a filler. This allows the array to be easily filled and insures that the ASCII code for a given key corresponds to the proper frequency.

Program Variations

One variation of this program you may want to try would be:

```
90 CALL SOUND (100,NOTE(Q),1,1.26*NOTE(Q),5,
   1.5*NOTE(Q),5)
```

This would produce a major chord for each key pressed. To create minor chords, try:

```
90 CALL SOUND (100, NOTE(Q),1,1.19*NOTE(Q),5,
   1.5*NOTE(Q),5)
```

If you change the duration from 100 to −150, the computer will play continuous tones. A value for a noise (−1 through −8) could be added to the CALL SOUND statement for an interesting effect. The space bar could be assigned a noise value for use as percussion. Since this program requires that the ALPHA LOCK be on, additional tones or noises could be assigned to what would be the lowercase letters.

Even though we do have a piano, our four-year-old daughter would rather play the computer. However, you can take the program further. You could include a routine within the program to print out the duration, frequency, and sequence of the notes you play on the computer's keyboard. This could be extremely helpful when tackling the laborious task of transposing sheet music so that it can be played by the computer. You could also try creating a routine that would play back any song played on the computer.

To make playing your computer/piano keyboard easier, you might want to buy two different colors of small gummed labels, like those sold in office supply stores. These may be placed on the computer keys to distinguish the white keys from the black keys. Novice musicians may also wish to write the name of the note on the label as an aid to playing. These labels can be easily removed when you are ready to let the computer go back to its regular keyboard functions.

Musical TI Keyboard

```
10 CALL CLEAR
20 DIM NOTE(47)
30 FOR C=1 TO 47
40 READ NOTE(C)
50 NEXT C
60 CALL KEY(0,N,S)
70 IF (N<44)+(N=45)+(N=49)+(N=52)+(
   N=56)+((N>57)*(N<66))+(N=68)+(N=
   72)+(N>90)THEN 60
80 Q=N-43
90 CALL SOUND(100,NOTE(Q),1)
100 GOTO 60
110 DATA 220,1,247,698,622,1,277,31
    1,1,370,415,466,1,554,1,1,1,1,1
    ,1,1,1,165,131,1,330,139,156,1
120 DATA 523,185,208,233,196,175,58
    7,659,262,349,117,392,494,147,2
    94,123,444,110
```

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CAPUTE!

Modifications Or Corrections To Previous Articles

64 Jackpot

The 64 version of this game from the August issue (Program 3, p. 89) requires the following two lines, which were accidentally omitted from the original listing:

```
5 PRINT"{CLR}";:POKE51,0:POKE55,0:POKE52,
  48:POKE56,48:CLR:GOSUB 60        :rem 61
10 TT=50:S=54272:FORL=STOS+24:POKEL,0:NEX
   T                                :rem 135
```

IBM PC/PCjr Blueberries

The IBM version (Program 3, p. 88) of this game in the July issue should work as published, but reader Michael Saletnik points out that the programmer used the VARPTR statement incorrectly in line 5000. VARPTR returns the starting address for the *descriptor* of the specified string variable. The descriptor is three bytes of data; the first byte tells the length of the string, and the other two hold the starting address within the current segment of memory where the characters that make up the string are stored. Thus, if you use a statement like V=VARPTR(ML$), then PRINT PEEK(V) will show the length of ML$, and PRINT PEEK(V+1)+256*PEEK(V+2) will give the starting address of the characters in ML$.

In line 5000, the calculated address ZZ does not point to the start of ML$ as intended, but rather off into some other part of the variable area. "Blueberries" works as printed because the programmer uses the computed address to POKE the machine language directly into memory in line 5010. A more standard way of transferring the machine language from DATA statements into ML$ would have been:

```
READ A: ML$=ML$+CHR$(A)
```

If the technique used in line 5010 had not been used, then the program would not have performed correctly. To place the machine language data properly into ML$, line 5000 should be changed to read:

```
5000 DEF SEG:ML$=SPACE$(48):V=VARPTR(ML$)
     :ZZ=PEEK(V+1)+256*PEEK(V+2)
```

Bunny Hop For The 64

Characters were omitted in two lines of the Commodore 64 version (Program 1, p. 74) of this game from the July issue. The final number in line 35 should be 208 instead of just 2, and the final number in line 200 should be 33 instead of 3. The corrected lines should read as follows:

```
35 DATA40,169,32,145,253,96,160,41,177,25
   3,136,145,253,200,200,192,81,208
200 POKEP,32:POKE37154,127:Y=PEEK(56320)A
    NDPEEK(QQ):IF(YAND8)=0THENP=P+1:D=33
```

VIC Olympiad

There is an error in one of the PRINT statements which defines the arena in the VIC version (Program 2, p. 56) of this game from the June issue. Ed Eyerman notes that there should be two spaces following the five SHIFTed spaces in line 3080. The line should read as follows:

```
3080 PRINT"{2 SHIFT-SPACE}{5 SPACES}{W}
     {2 SPACES}{Q}{5 SHIFT-SPACE}
     {2 SPACES}";
```

Also, line 1045 in the VIC version is an unintentional carryover from the original Commodore 64 version, and can be deleted. ©

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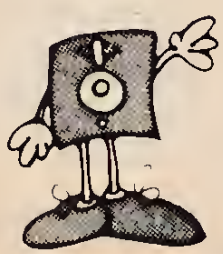

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Tiny MLX Machine Language Entry Program

For Unexpanded VIC-20

Charles Brannon Program Editor

MLX is a labor-saving utility that allows almost fail-safe entry of machine language programs published in COMPUTE!. *You need to know nothing about machine language to use MLX—it was designed for everyone. "Tiny MLX" is a special version for the unexpanded VIC.*

MLX is a new way to enter long machine language (ML) programs with a minimum of fuss. MLX lets you enter the numbers from a special list that looks similar to BASIC DATA statements. It checks your typing on a line-by-line basis. It won't let you enter illegal characters when you should be typing numbers. It won't let you enter numbers greater than 255 (forbidden in ML). It won't let you enter the wrong numbers on the wrong line. In addition, MLX creates a ready-to-use tape or disk file.

Using MLX

Type in and save "Tiny MLX" (you'll want to use it in the future). When you're ready to type in an ML program, run Tiny MLX. Unlike regular MLX, Tiny MLX does not ask for the starting and ending address of the program to be entered. Instead, this information must be included in line 210. The values currently shown in line 210 are for the "Lightsaver" program in this issue.

You'll see a prompt corresponding to the starting address. The prompt is the current line you are entering from the listing. It increases by six each time you enter a line. That's because each line has seven numbers—six actual data numbers plus a *checksum number*. The checksum verifies that you typed the previous six numbers correctly. If you enter any of the six numbers wrong, or enter the checksum wrong, the computer rings a buzzer and prompts you to reenter the line. If you enter it correctly, a bell tone sounds and you continue to the next line.

MLX accepts only numbers as input. If you make a typing error, press the INST/DEL key; the entire number is deleted. You can press it as many times as necessary back to the start of the line. If you enter three-digit numbers as listed, the computer automatically prints the comma and goes on to accept the next number. If you enter less than three digits, you can press either the comma, space bar, or RETURN key to advance to the next number. The checksum automatically appears in reverse video for emphasis.

MLX Commands

When you finish typing an ML listing, you can then save the completed program on tape or disk. Follow the screen instructions. If you get any errors while saving, you probably have a bad disk, or the disk is full, or you made a typo when entering the MLX program itself.

Since Tiny MLX has no provisions for reloading a partially completed program, you must enter the ML program all in one sitting.

Tiny MLX

```
100 POKE55,174:POKE56,23:CLR:POKE700,194    :rem 76
210 S=6063:E=7650                           :rem 136
300 PRINT"{CLR}";CHR$(14):AD=S              :rem 56
310 PRINTRIGHT$("0000"+MID$(STR$(AD),2),5);":";:FO
    RJ=1TO6                                 :rem 234
320 GOSUB570:IFN=-1THENJ=J+N:GOTO320        :rem 220
400 IFN<0THENPRINT:GOTO310                  :rem 160
490 A(J)=N:NEXTJ                            :rem 199
500 CKSUM=AD-INT(AD/256)*256:FORI=1TO6:CKSUM=(CKSU
    M+A(I))AND255:NEXT                      :rem 200
510 PRINTCHR$(18);:GOSUB570:PRINTCHR$(20)   :rem 234
515 IFN=CKSUMTHEN530                        :rem 255
520 PRINT:PRINT"LINE ENTERED WRONG":PRINT"RE-ENTER
    ":PRINT:GOSUB1000:GOTO310               :rem 129
530 GOSUB2000                               :rem 210
540 FORI=1TO6:POKEAD+I-1,A(I):NEXT          :rem 00
550 AD=AD+6:IFAD<ETHEN310                   :rem 212
560 GOTO710                                 :rem 100
570 N=0:Z=0                                 :rem 00
580 PRINT"{3 RIGHT}";                       :rem 79
581 GETA$:IFA$=""THEN581                    :rem 95
585 PRINTCHR$(20);:A=ASC(A$):IFA=13ORA=44ORA=32THE
    N670                                    :rem 229
590 IFA>12ØTHENN=-A:RETURN                  :rem 137
600 IFA<>20 THEN 630                        :rem 10
610 GOSUB690:IFI=1ANDT=44THENN=-1:PRINT"{LEFT}
    {LEFT}";:GOTO690                        :rem 172
620 GOTO570                                 :rem 109
630 IFA<40ORA>57THEN500                     :rem 105
640 PRINTA$;:N=N*10+A-40                    :rem 106
650 IFN>255 THEN A=20:GOSUB1000:GOTO600     :rem 229
660 Z=Z+1:IFZ<3THEN500                      :rem 71
670 IFZ=0THENGOSUB1000:GOTO570              :rem 114
680 PRINT",";:RETURN                        :rem 240
690 S%=PEEK(209)+256*PEEK(210)+PEEK(211)    :rem 149
692 FORI=1TO3:T=PEEK(S%-I)                  :rem 60
695 IFT<>44ANDT<>50THENPOKES%-I,32:NEXT     :rem 205
700 PRINTLEFT$("{3 LEFT}",I-1);:RETURN      :rem 7
710 PRINT"{CLR}{RVS}*** SAVE ***{3 DOWN}"   :rem 236
720 INPUT"{DOWN} FILENAME";F$               :rem 220
730 PRINT:PRINT"{2 DOWN}{RVS}T{OFF}APE OR {RVS}D
    {OFF}ISK: (T/D)"                        :rem 220
740 GETA$:IFA$<>"T"ANDA$<>"D"THEN740        :rem 36
750 DV=1-7*(A$="D"):IFDV=0THENF$="0:"+F$    :rem 150
760 T$=F$:ZK=PEEK(53)+256*PEEK(54)-LEN(T$):POKE782
    ,ZK/256                                 :rem 3
762 POKE701,ZK-PEEK(702)*256:POKE700,LEN(T$):SYS65
    469                                     :rem 109
763 POKE780,1:POKE701,DV:POKE702,1:SYS65466:rem 69
765 POKE254,S/256:POKE253,S-PEEK(254)*256:POKE700,
    253                                     :rem 12
766 POKE702,E/256:POKE701,E-PEEK(702)*256:SYS65496
                                            :rem 124
770 IF(PEEK(703)AND1)OR(ST AND191)THEN700   :rem 111
775 PRINT"{DOWN}DONE.":END                  :rem 106
700 PRINT"{DOWN}ERROR ON SAVE.{2 SPACES}TRY AGAIN.
    ":IFDV=1THEN720                         :rem 171
701 OPEN15,8,15:INPUT#15,E1$,E2$:PRINTE1$;E2$:CLOS
    E15:GOTO720                             :rem 103
702 GOTO720                                 :rem 115
045 POKE700,1:POKE701,DV:POKE782,1:SYS65466:rem 70
1000 REM BELL TONE                          :rem 250
1001 POKE36070,15:POKE36074,190             :rem 206
1002 FORW=1TO300:NEXTW                      :rem 117
1003 POKE36070,0:POKE36074,0:RETURN         :rem 74
2000 REM BELL SOUND                         :rem 70
2001 FORW=15TO0STEP-1:POKE36870,W:POKE36076,240:NE
    XTW                                     :rem 22
2002 POKE36076,0:RETURN                     :rem 119
```


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MLX Machine Language Entry Program For VIC-20

Charles Brannon, Program Editor

MLX is a labor-saving utility that allows almost fail-safe entry of machine language programs published in COMPUTE!. *You need to know nothing about machine language to use MLX—it was designed for everyone.*

MLX is a new way to enter long machine language (ML) programs with a minimum of fuss. MLX lets you enter the numbers from a special list that looks similar to BASIC DATA statements. It checks your typing on a line-by-line basis. It won't let you enter illegal characters when you should be typing numbers. It won't let you enter numbers greater than 255 (forbidden in ML). It won't let you enter the wrong numbers on the wrong line. In addition, MLX creates a ready-to-use tape or disk file. You can then use the LOAD command to read the program into the computer:

```
LOAD "filename",1,1   (for tape)
LOAD "filename",8,1   (for disk)
```

To start the program, you enter a SYS command that transfers control from BASIC to machine language. The starting SYS number appears in the article.

Using MLX

Type in and save MLX for your 64 (you'll want to use it in the future). When you're ready to type in an ML program, run MLX. MLX asks you for two numbers: the starting address and the ending address. These numbers are given in the article accompanying the ML program.

You'll see a prompt corresponding to the starting address. The prompt is the current line you are entering from the listing. It increases by six each time you enter a line. That's because each line has seven numbers—six actual data numbers plus a *checksum number*. The checksum verifies that you typed the previous six numbers correctly. If you enter any of the six numbers wrong, or enter the checksum wrong, the computer rings a buzzer and prompts you to reenter the line. If you enter it correctly, a bell tone sounds and you continue to the next line.

MLX accepts only numbers as input. If you make a typing error, press the INST/DEL key; the entire number is deleted. You can press it as many times as necessary back to the start of the line. If you enter three-digit numbers as listed, the computer automatically prints the comma and goes on to accept the next number. If you enter less than three digits, you can press either the SPACE bar, or RETURN key to advance to the next number. The checksum automatically appears in inverse video for emphasis.

To simplify your typing, MLX redefines part of the keyboard as a numeric keypad (lines 581–584):

```
    U I O              7 8 9
H   J K L   become 0   4 5 6
    M                  1 2 3
```

MLX Commands

When you finish typing an ML listing (assuming you type it all in one session), you can then save the completed program on tape or disk. Follow the screen instructions. If you get any errors while saving, you probably have a bad disk, or the disk is full, or you've made a typo when entering the MLX program itself.

You don't have to enter the whole ML program in one sitting. MLX lets you enter as much as you want, save it, and then reload the file from tape or disk later. MLX recognizes these commands:

SHIFT-S: Save
SHIFT-L: Load
SHIFT-N: New Address
SHIFT-D: Display

When you enter a command, MLX jumps out of the line you've been typing, so we recommend you do it at a new prompt. Use the Save command to save what you've been working on. It will save on tape or disk as if you've finished, but the tape or disk won't work, of course, until you finish the typing. Remember what address you stop at. The next time you run MLX, answer all the prompts as you did before, then insert the disk or tape. When you get to the entry prompt, press SHIFT-L to reload the partly completed file into memory. Then use the New Address command to resume typing.

To use the New Address command, press SHIFT-N and enter the address where you previously stopped. The prompt will change, and you can then continue typing. Always enter a New Address that matches up with one of the line numbers in the special listing, or else the checksum won't work. The Display command lets you display a section of your typing. After you press SHIFT-D, enter two addresses within the line number range of the listing. You can abort the listing by pressing any key.

What if you forgot where you stopped typing? Use the Display command to scan memory from the beginning to the end of the program. When you reach the end of your typing, the lines will contain a random pattern of numbers. When you see the end of your typing, press any key to stop the listing. Use the New Address command to continue typing from the proper location.

MLX: Machine Language Entry

```
100 PRINT"{CLR}{PUR}";CHR$(142);CHR$(8);
                                    :rem 181
101 POKE 788,194:REM DISABLE RUN/STOP
                                    :rem 174
110 PRINT"{RVS}{14 SPACES}"         :rem 117
120 PRINT"{RVS} {RIGHT}{OFF}{*}£{RVS}
    {RIGHT} {RIGHT}{2 SPACES}{*}{OFF}{*}
    £{RVS}£{RVS} "                  :rem 191
130 PRINT"{RVS} {RIGHT} {G}{RIGHT}
    {2 RIGHT} {OFF}£{RVS}£{*}{OFF}{*}
```

```
    {RVS} "                          :rem 232
140 PRINT"{RVS}{14 SPACES}"          :rem 120
200 PRINT"{2 DOWN}{PUR}{BLK}A FAILSAFE MA
    CHINE":PRINT"LANGUAGE EDITOR{5 DOWN}"
                                     :rem 141
210 PRINT"{BLK}{3 UP}STARTING ADDRESS":IN
    PUTS:F=1-F:C$=CHR$(31+119*F)     :rem 97
220 IFS<256ORS>32767THENGOSUB3000:GOTO210
                                     :rem 2
225 PRINT:PRINT:PRINT:PRINT          :rem 123
230 PRINT"{BLK}{3 UP}ENDING ADDRESS":INPU
    TE:F=1-F:C$=CHR$(31+119*P)       :rem 158
240 IFE<256ORE>32767THENGOSUB3000:GOTO230
                                     :rem 234
250 IFE<STHENPRINTC$;"{RVS}ENDING < START
    {2 SPACES}":GOSUB1000:GOTO 230
                                     :rem 176
260 PRINT:PRINT:PRINT                :rem 179
300 PRINT"{CLR}";CHR$(14):AD=S       :rem 56
310 PRINTRIGHT$("0000"+MID$(STR$(AD),2),5
    );":";:FORJ=1TO6                 :rem 234
320 GOSUB570:IFN=-1THENJ=J+N:GOTO320
                                     :rem 228
390 IFN=-211THEN 710                 :rem 62
400 IFN=-204THEN 790                 :rem 64
410 IFN=-206THENPRINT:INPUT"{DOWN}ENTER N
    EW ADDRESS";ZZ                   :rem 44
415 IFN=-206THENIPZZ<SORZZ>ETHENPRINT"
    {RVS}OUT OF RANGE":GOSUB1000:GOTO410
                                     :rem 225
417 IPN=-206THENAD=ZZ:PRINT:GOTO310
                                     :rem 238
420 IP N<>-196 THEN 480              :rem 133
430 PRINT:INPUT"DISPLAY:FROM";F:PRINT,"TO
    ";:INPUTT                        :rem 234
440 IFF<SORF>EORT<SORT>ETHENPRINT"AT LEAS
    T";S;"{LEFT}, NOT MORE THAN";E:GOTO43
    0                                :rem 159
450 FORI=FTOTSTEP6:PRINT:PRINTRIGHT$("000
    0"+MID$(STR$(I),2),5);":";       :rem 30
455 FORK=0TO5:N=PEEK(I+K):IFK=3THENPRINTS
    PC(10);                          :rem 34
457 PRINTRIGHT$("00"+MID$(STR$(N),2),3);"
    ,";                              :rem 157
460 GETA$:IFA$>""THENPRINT:PRINT:GOTO310
                                     :rem 25
470 NEXTK:PRINTCHR$(20);:NEXTI:PRINT:PRIN
    T:GOTO310                        :rem 50
480 IFN<0 THEN PRINT:GOTO310         :rem 168
490 A(J)=N:NEXTJ                     :rem 199
500 CKSUM=AD-INT(AD/256)*256:FORI=1TO6:CK
    SUM=(CKSUM+A(I))AND255:NEXT      :rem 200
510 PRINTCHR$(18);:GOSUB570:PRINTCHR$(20)
                                     :rem 234
515 IFN=CKSUMTHEN530                 :rem 255
520 PRINT:PRINT"LINE ENTERED WRONG":PRINT
    "RE-ENTER":PRINT:GOSUB1000:GOTO310
                                     :rem 129
530 GOSUB2000                        :rem 218
540 FORI=1TO6:POKEAD+I-1,A(I):NEXT:rem 80
550 AD=AD+6:IF AD<E THEN 310         :rem 212
560 GOTO 710                         :rem 108
570 N=0:Z=0                          :rem 88
580 PRINT"{+}";                      :rem 79
581 GETA$:IFA$=""THEN581             :rem 95
585 PRINTCHR$(20);:A=ASC(A$):IFA=13ORA=44
    ORA=32THEN670                    :rem 229
590 IFA>128THENN=-A:RETURN           :rem 137
600 IFA<>20 THEN 630                 :rem 10
610 GOSUB690:IFI=1ANDT=44THENN=-1:PRINT"
    {LEPT} {LEFT}";:GOTO690          :rem 172
620 GOTO570                          :rem 109
630 IFA<48ORA>57THEN580              :rem 105
640 PRINTA$;:N=N*10+A-48             :rem 106
650 IFN>255 THEN A=20:GOSUB1000:GOTO600
                                     :rem 229
660 Z=Z+1:IFZ<3THEN580               :rem 71
670 IPZ=0THENGOSUB1000:GOTO570       :rem 114
680 PRINT",";:RETURN                 :rem 240
690 S%=PEEK(209)+256*PEEK(210)+PEEK(211)
                                     :rem 149
692 FORI=1TO3:T=PEEK(S%-I)           :rem 68
695 IFT<>44ANDT<>58THENPOKES%-I,32:NEXT
                                     :rem 205
700 PRINTLEFT$("{3 LEFT}",I-1);:RETURN
                                     :rem 7
710 PRINT"{CLR}{RVS}*** SAVE ***{3 DOWN}"
                                     :rem 236
720 INPUT"{DOWN} FILENAME";F$        :rem 228
730 PRINT:PRINT"{2 DOWN}{RVS}T{OFF}APE OR
    {RVS}D{OFF}ISK: (T/D)"           :rem 228
740 GETA$:IFA$<>"T"ANDA$<>"D"THEN740
                                     :rem 36
750 DV=1-7*(A$="D"):IFDV=BTHENF$="0:"+P$
                                     :rem 158
760 T$=F$:ZK=PEEK(53)+256*PEEK(54)-LEN(T$
    ):POKE782,ZK/256                 :rem 3
762 POKE781,ZK-PEEK(782)*256:POKE780,LEN(
    T$):SYS65469                     :rem 109
763 POKE780,1:POKE781,DV:POKE782,1:SYS654
    66                               :rem 69
765 POKE254,S/256:POKE253,S-PEEK(254)*256
    :POKE7B0,253                     :rem 12
766 POKE782,E/256:POKE781,E-PEEK(782)*256
    :SYS65496                        :rem 124
770 IP(PEEK(783)AND1)OR(ST AND191)THEN780
                                     :rem 111
775 PRINT"{DOWN}DONE.":END           :rem 106
780 PRINT"{DOWN}ERROR ON SAVE.{2 SPACES}T
    RY AGAIN.":IFDV=1THEN720         :rem 171
781 OPEN15,8,15:INPUT#15,E1$,E2$:PRINTE1$
    ;E2$:CLOSE15:GOTO720             :rem 103
782 GOTO720                          :rem 115
790 PRINT"{CLR}{RVS}*** LOAD ***{2 DOWN}"
                                     :rem 212
800 INPUT"{2 DOWN} FILENAME";F$      :rem 244
810 PRINT:PRINT"{2 DOWN}{RVS}T{OFF}APE OR
    {RVS}D{OFF}ISK: (T/D)"           :rem 227
820 GETA$:IPA$<>"T"ANDA$<>"D"THEN820
                                     :rem 34
830 DV=1-7*(A$="D"):IFDV=8THENF$="0:"+P$
                                     :rem 157
840 T$=F$:ZK=PEEK(53)+256*PEEK(54)-LEN(T$
    ):POKE7B2,ZK/256                 :rem 2
841 POKE781,ZK-PEEK(782)*256:POKE780,LEN(
    T$):SYS65469                     :rem 107
845 POKE780,1:POKE781,DV:POKE7B2,1:SYS654
    66                               :rem 70
850 POKE780,0:SYS65493               :rem 11
860 IF(PEEK(783)AND1)OR(ST AND191)THEN870
                                     :rem 111
865 PRINT"{DOWN}DONE.":GOTO310       :rem 96
870 PRINT"{DOWN}ERROR ON LOAD.{2 SPACES}T
    RY AGAIN.{DOWN}":IFDV=1THEN800
                                     :rem 172
880 OPEN15,8,15:INPUT#15,E1$,E2$:PRINTE1$
    ;E2$:CLOSE15:GOTO800             :rem 102
1000 REM BUZZER                      :rem 135
1001 POKE36878,15:POKE36874,190      :rem 206
1002 PORW=1TO300:NEXTW               :rem 117
1003 POKE36878,0:POKE36874,0:RETURN
                                     :rem 74
2000 REM BELL SOUND                  :rem 78
2001 PORW=15TO0STEP-1:POKE36B7B,W:POKE368
     76,240:NEXTW                    :rem 22
2002 POKE36876,0:RETURN              :rem 119
3000 PRINTC$;"{RVS}NOT ZERO PAGE OR ROM":
     GOTO1000                        :rem 89
```

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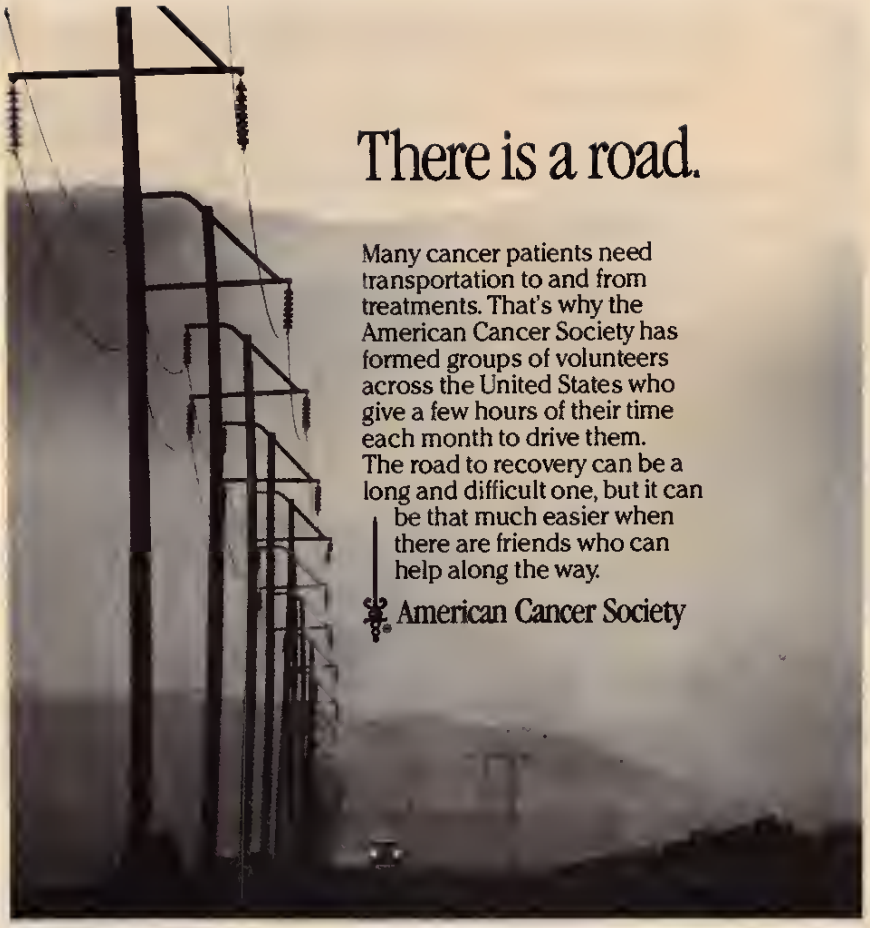

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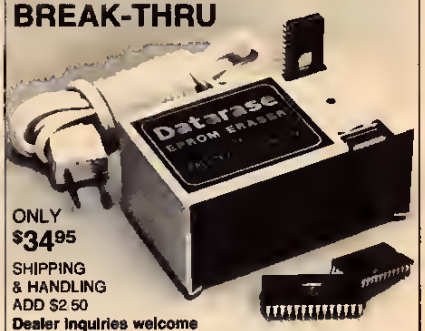

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